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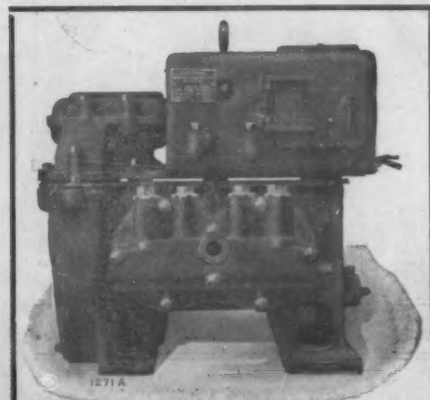

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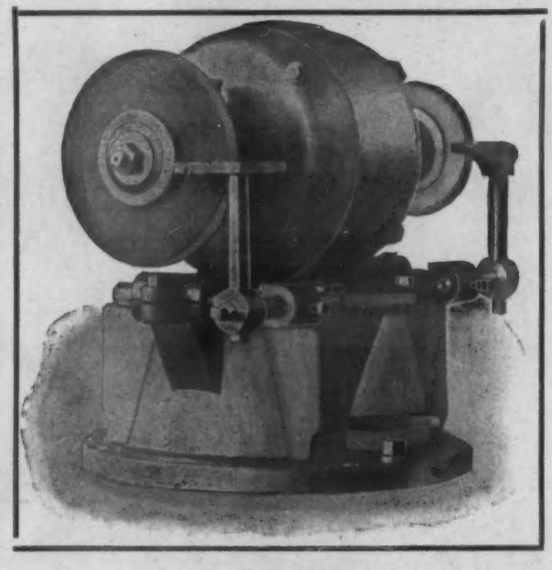

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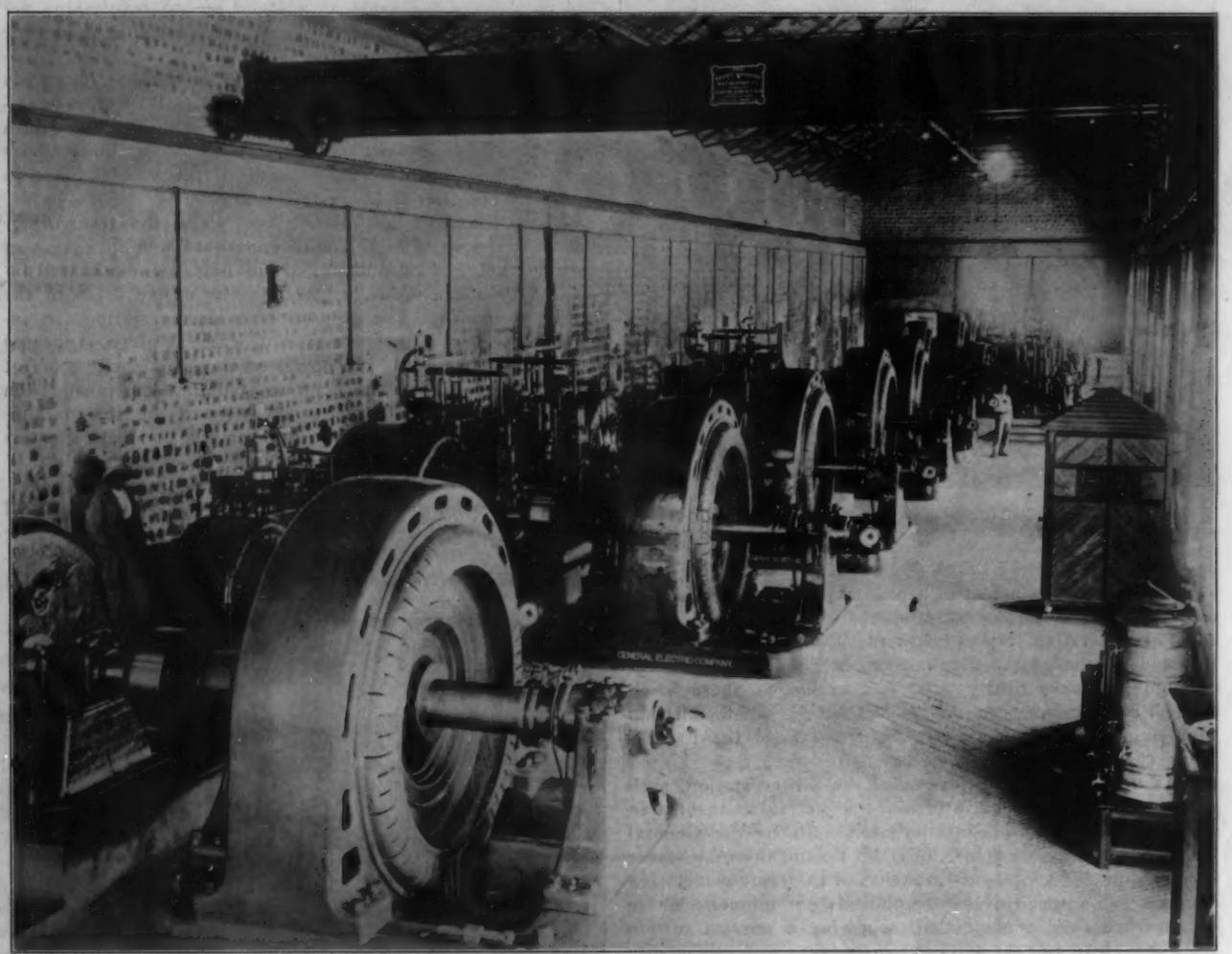
VOLUME XVIII. SAN FRANCISCO, CAL., FEBRUARY 23, 1907 No. 8

## The Great Cauvery Hydro-Electric Development in India

The Cauvery falls are in the province of Mysore, in Southern Asia, not far from the village of Sivasamundram, a Hindu settlement in India, where an abundance of water power is available during the rainy season, approaching a quarter of a million horsepower. There is a fall of about a third of a mile in length and of V shape construction. The power plant supplies current over a transmission line of nearly 100 miles in length, with a pressure of 35,000 volts, to the Kolar gold fields, where the electric power is utilized for operating the mining machinery.



INTERIOR GENERATING STATION, SIVASAMUDRAM, MYSORE, INDIA.

400 feet, and during the dry season there is about 10,000 horsepower capable of being utilized, by the power plant at present installed and under development.

There are two branches of the river which are diverted into the channel intake by two dams, one of which is nearly

In addition to this use of the power, provision is made for supplying light and power to the city of Bangalore, which has a population of about 200,000 inhabitants, this transmission line being about two-thirds as long as the one to the Kolar gold fields.

The Cauvery power house noted in the accompanying illustration, which shows the interior with its electrical generators and hydraulic turbines, is located about one mile below the Cauvery falls, while the head gates at the channel entrances are installed nearly the same distance above the falls. There are two channels about three miles long following natural grades or contour of that section, the sides of the two channels being from 10 to 30 feet apart, respectively, at top and base. These channels have trapezoidal sections, the bed width being about 12 feet in rock and 18 feet in earth cutting.

The accompanying illustrations show the construction of the head and scouring sluice, and the eight vent aqueduct of the supply channels. The water is supplied from the intake at the head works through four vents to each channel. These vents each measure about 5 feet by 5 feet in section, the flow in the channels varying from two to three feet per second, according to the gate opening. The scouring sluice vents are about the same sections as the other 5 feet by 4½ feet arranged on the river side of the intake channel.

There are two parts to the forebay, one of which supplies water to the new penstocks and the other to the old ones, the two channels supplying water through the double fore-

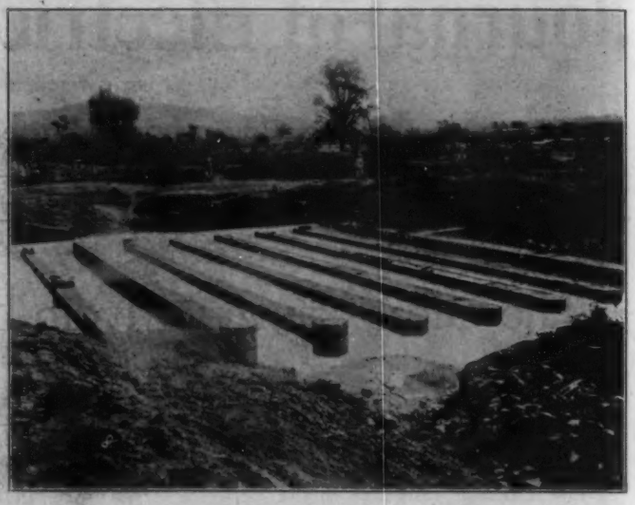
HEAD AND SCOURING SLUICE, CAUVERY, INDIA.

bay to eight penstocks in all, the water in the forebay being not over a half dozen feet in depth, with the surplus passing over the waste weir.

The generating station below the bank, the site of which is noted in one of the illustrations, is supplied with water through penstocks nearly 1,000 feet in length, these being of steel construction, each of the five for the last installation supplying water to an impulse water wheel of the Escher-Wyss type of 1250 horsepower capacity.

As noted in the illustration of the power station, each of these horizontal impulse turbines is directly connected to a 750 kilowatt three-phase alternator, built by the General Electric Company, of Schnectady, N. Y., and there are three exciter units of 75 kilowatts capacity, of the same make, each operating at a speed of 465 revolutions per minute. These exciters are over compounded, supplying a current of 110 volts at no load and 115 volts at full load.

It is stated that one of these exciters is capable of exciting the fields of the generators for a load of 5,500 kilowatts at the station with a power factor of 95 per cent., but two exciters are utilized, the third being held as a reserve and for station lighting, the full load of the power house being about 7,000 kilowatts.



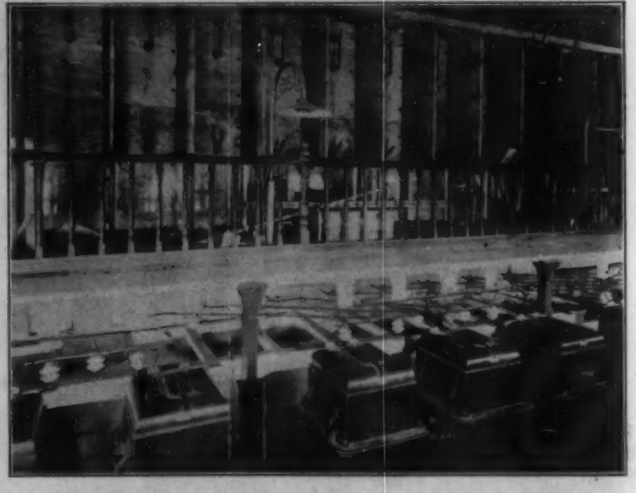
EIGHT VENT AQUEDUCT (SUPPLY CHANNEL) CAUVERY, INDIA.

The main alternators supply a three-phase current of 2,200 volts pressure with a frequency of 25 cycles per second. The horizontal turbines are directly coupled to the alternators, driving the same at a speed of 300 revolutions per minute, these generators being of the revolving field type with Y electrical connections.

It is stated that the efficiency of the turbines is 70 per cent. at half load and 75 per cent. at full load of 1,250 horsepower, this being developed with a head of 382 feet and a flow of 37 cubic feet per minute. The power station is about 260 feet long and between 50 and 60 feet in width, and is built of black trap and granite.

The accompanying illustrations show the transformer house at the head of the bluff completed and in course of construction, and the method of building in India is well indicated by these views, as well as the native dress of the native workmen. The step-up transformer station, an interior as well as an exterior view of which is given, is located about 1,000 feet from the power station and about 400 feet above it on the bluff, and from this building the transmission lines carry the current at 35,000 volts to the various substations, one of which is shown with the conductors entering the step down transformer building.

The current is raised in pressure from that of the generators 2,200 volts to 35,000 volts by means of seven banks of air-cooled, step-up transformers, built by the General Electric Company, at Schenectady, each having a capacity of 350 kilowatts. The power station and transformer house are both

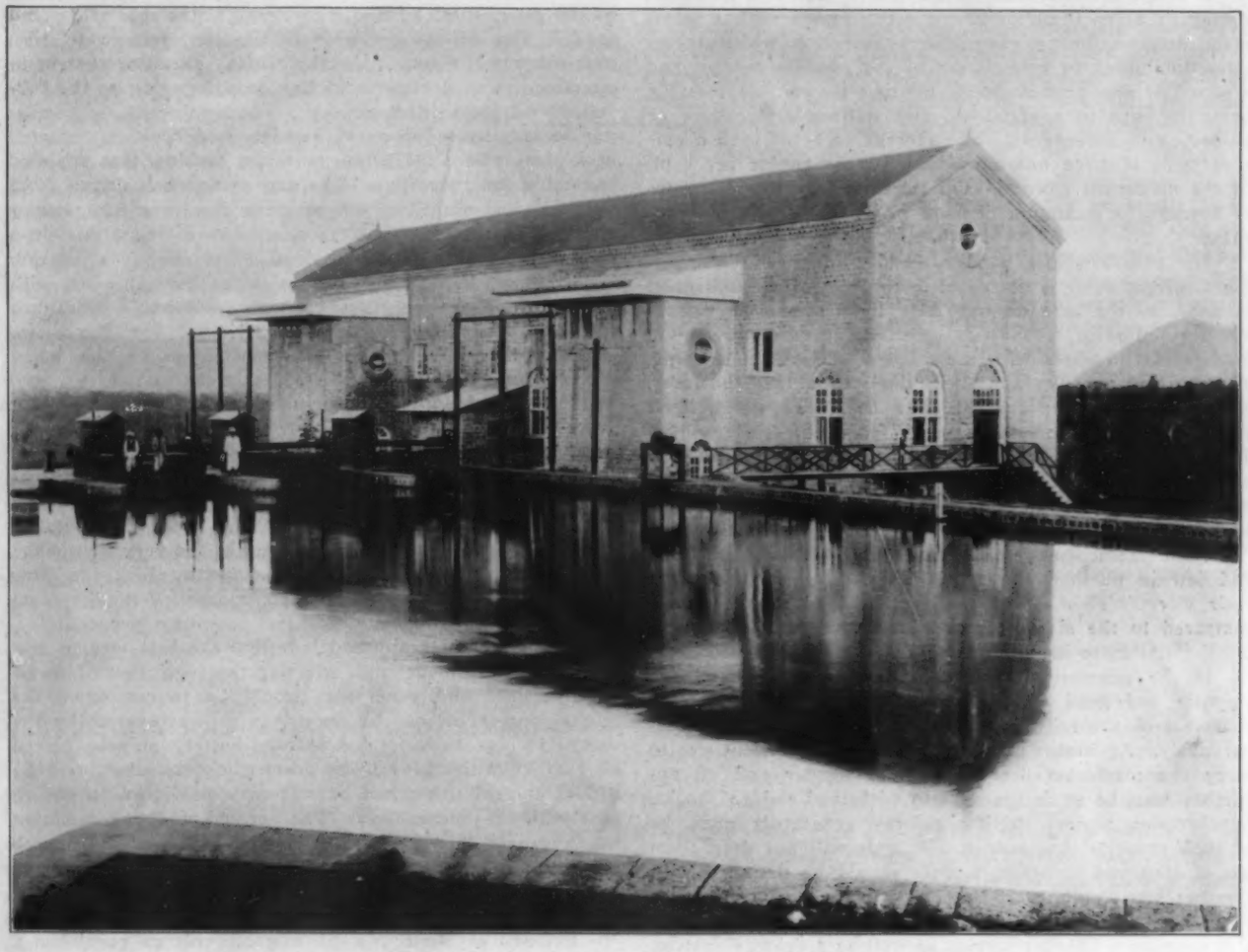


INTERIOR TRANSFORMER HOUSE, CAUVERY, INDIA.

divided into two sections, which may be operated separately or together, as desired. Motor operated oil switches, of the quick acting 2,200 volt type, are used between the two sets of low tension bus bars.

Automatic motor operated double break oil switches of 35,000 volts are used on the high tension lines, one for each transmission circuit, an automatic bellows time limit relay being employed to trip the switches at about 100 per cent. overload. There are two General Electric voltage regulators employed, connected in multiple, one being adjusted for high voltage and the other for low voltage range, controlling the pressure from 115 volts full load to 95 volts no load. The entrance of the high tension wires. This acts as a rain guard, as the monsoon weather is very trying in India, in keeping the insulation perfect. It is stated, however, that more difficulty is found with the low tension Kolar distribution lines than with the high tension circuits, the trouble resulting from the driving rain entering the distribution towers during rainstorms and severe winds being very aggravating.

It is maintained that this hydro-electric power transmission in southern India has given excellent satisfaction, supplying cheap power to the mines, as well as providing all of the comforts which electricity can give, in the way of lighting, heating and power service to the inhabitants of Bangalore.



EXTERIOR STEP-UP TRANSFORMER STATION, SIVASAMUDRAM, MYSORE, INDIA.

regulation takes place automatically with the change of load keeping the voltage constant at the distribution end of the line. The voltage regulator may be operated with one exciter or two or more exciters in parallel, and it is claimed that they are of great value in keeping the transmission line pressure from exceeding a wave voltage in case the station load should all be thrown off, by accident or other cause, acting advantageously with the impulse turbine governors.

It is stated that the voltage is held practically constant at about 30,000 volts at the receiving end of the long distance transmission line at the Kolar gold mines, even though the variation at the power house is from 30,000 volts to 37,000 volts, according to the load, from a maximum to no load. It is held that the line loss is about 15 per cent. at ordinary loads, the potential loss being about 6,000 volts at full load and less than 1,000 volts at no load, the power factor in the former case being 95 per cent. The accompanying illustration of the step down transformer station shows the roof to be extended to an unusual amount on the side near the

## ONE HUNDRED YEARS HENCE.

Considerable discussion has been aroused by a signed prophecy of Thomas A. Edison, detailing what our large cities will be like one hundred years hence. He says they will be free from smoke and steam and that the chimney will be a thing of the past, while the waste of coal and other fuel will be stopped through the use of electricity, generated direct from the fuel without the aid of engine, boiler or dynamo. In factories each machine will have its individual motor. Houses will be heated electrically and most of the cities' noises will cease. Skyscrapers will be universal in the business section, and the streets will be bridged over at different heights to facilitate transit from one side to the other. He estimates that buildings will then average thirty stories in height, and the greater number will be constructed of concrete and steel. Such buildings, he says, will stand a thousand years or longer.

## RAILWAY GENERATING AND SUB-STATIONS.

By Elbert G. Allen*

The principal feature which characterizes a railway load in its effect upon a generating and distributing system is its fluctuating character. The output to a railway system is never steady. A lightening load varies from hour to hour but its changes are gradual and from time to time the output is steadily increasing or diminishing without material fluctuations.

A single car impresses on the central station a load consisting of a repetition of motor accelerations with a maximum demand during rheostatic acceleration which thereafter diminishes to a minimum of the running current and a period of zero demand during the time the car is coasting, being brought to a standstill, and waiting for loading or unloading of passengers. The average value of such a current cycle is often not more than ten or twelve per cent. of the maximum demand. On interurban service the ratio of average to maximum demand may reach a much larger value.

On suburban line with a number of cars, the maximum current value is not equal to the sum of the individual maxima, as the cars do not start simultaneously. Consequently the ratio of average to maximum demand or the load factor increases with the number of cars on the line. The starting currents appear in the station load, however, as fluctuations super-imposed on a base load which itself varies from hour to hour as the amount of traffic varies. The load factor of an extension system during an hour when the average is uniform, may reach as high as fifty or sixty per cent. The monthly load factor on such a system may be as high as forty per cent. or more.

With interurban systems where the train units are large and few in number, the conditions of load factor are at their worst. Then, while the average load may be small compared to the size of the apparatus, the maximum may tax the station to its utmost.

If the generating system is used solely for railway purposes and good voltage is non-essential, this fluctuating character of the railway load is of little importance, comparatively. Apparatus must of course be of sufficient size to carry the maximum demand without danger and all apparatus must be so designed as to withstand sudden shocks. Synchronous motors driving railway generators must be of such capacity that sudden overloads will not drag them out of step and induction motors should be designed with a rather high "pulling out" point.

When, as is often the case, the generating equipment also supplies a lighting service as well as a railway system, the presence of the fluctuating load becomes more serious by its effect on the regulation. In such cases great care is necessary in the design of the entire system to eliminate the effect of these fluctuations. The prime movers should be controlled by governors, which give a close regulation from no load to full load. It is not, however, customary to compound the generators supplying a mixed service. Fortunately the momentary fluctuations are usually of small percentage value at the generator of a large mixed system. There are, however, ways of keeping the generator voltage steady, irrespective of output. The best of these is probably the Tirrill regulator. This very effective regulator operates on the fields of the exciter by short circuiting the field rheostat. The regulator is under the control of a solenoid supplied from the generator brises. When the voltage drops slightly the regulator operates to short circuit the field rheostat of the exciter, causing the exciter voltage to suddenly rise. This rise causes the regulator contacts to open again, but the rise in exciter voltage has by this time raised the generator voltage to normal. The result is a continuous vibration of the regulator contacts, the relative of time during which they are closed determining the average exciter voltage in accordance with the necessities of the generator to maintain the voltage for which the regulator is set.

Transmission line losses cause railway fluctuations to have a serious influence on the regulation of lighting circuits supplied over the same line. Their effect may often be rendered negligable by the use of Tirrill regulators, operating on synchronous motors or rotary converters. The action in this case is similar to that when the regulators act on the generators. Should the voltage at the substation tend to fall, the regulator causes the exciter voltage to rise, over-exciting the motor, thereby causing a leading current to circulate, which decreases the line drop, bringing up the substation voltage to normal.

An aggravated case of regulation difficulties occurred in a plant where the prime mover, a turbine, was supplied through a long pipe line. The exciter was belt driven from the main wheel. The transmission line was temporarily operated at a comparatively low voltage, giving a line drop of about 15 per cent. at full load. The railway substation was equipped with a synchronous motor generator set, with direct connected exciter. These very undesirable conditions were made necessary by the situation, particularly as regards funds available for the construction of the water power plant.

Poor regulation was anticipated and a Tirrill regulator provided for the substation. Provision was also made for steadying the water pressure by keeping the flow through the pipe line uniform. Without the regulator voltage fluctuations of over 25 per cent. were observed, due to the fact that as load increased and the wheel speed momentarily dropped, the exciter voltages dropped at the very time when they should have been high to compensate for the slow speed of generator and synchronous motor. With the regulator cut in, the fluctuation is less than two per cent.

One might naturally conclude that the best way to prevent fluctuating loads from affecting the regulation of transmission lines and generators would be to cut down the fluctuations. This can be done in a railway system by the use of storage batteries. A storage battery may be placed in parallel with the railway converting machines, and by proper control through a booster may be forced to absorb nearly all the fluctuations. The output of the connecting machinery is then practically constant, varying only with the average output of the station and the generating and transmission system being relieved of fluctuations good regulation is easy to maintain.

Before the perfection of a good voltage regulator a storage battery was often necessary in a substation on the score of regulation. The value of the battery is today more often decided by economic reasons, as the regulation can nearly always be obtained if necessary without the battery.

Rotary converters and motor generator sets are both used in railway substations. For systems with low frequency rotary converters are often preferable on account of their higher efficiency. With a frequency of sixty cycles rotaries become somewhat objectionable on account of their tendency to "hunt," and their liability to flash across between direct-current brushes and fall out of step with any disturbance on the supply circuits. Rotaries also have less range of voltage control through power factor variations on account of their liability to hunt with lagging or leading currents.

Motor generators, despite their poorer efficiency, are often preferable to motor generator sets on account of their greater stability of operation. The fact that motors can be wound for voltage up to about 13,200 often avoids the necessity for static transformers, reducing the cost, increasing the efficiency and simplifying the station lay out.

*This is the third of the series of lectures delivered by Mr. Allen to the class in Electric Railways, University of Washington.

For small substations induction motors are frequently satisfactory for motor generator sets and make the operation much simpler, as no care of synchronizing is necessary. On account of their value in voltage regulating, however, synchronous motors are more often advisable.

Synchronous motor generator sets or rotaries are sometimes very superior to induction sets, as in case of trouble they may be run inverted and alternating circuits supplied from storage batteries for short intervals during repairs, etc.

Electrical apparatus is usually given three ratings, first, the output which it will give continuously without undue heating; second, the overload which it will safely carry for a certain interval, say two hours; and third, the amount of overload which may be carried momentarily without undue strain, commutator trouble or falling out of step. With fluctuating loads the equivalent heating is more than that produced by the equivalent steady average output, as copper losses are proportional to the square of the current. Consequently a railway machine should be rated somewhat higher than the average load which it carries.

Where continuity of service is a necessity, as is almost universally the case in modern practice, there should be in every station a spare machine or spare capacity in the case of overload capacity of machines in service equal to the load carried by the largest unit. For example, a station containing three 500 kilowatt machines, each capable of carrying 50 per cent. overload during rush hours, should not be loaded above 1500 kilowatts at peak, which is a 50 per cent. overload on two machines. For otherwise, if one machine were disabled the two remaining would be loaded beyond their safe capacity.

It should be possible to shut down machine, oil switch, supply line, etc., without impairing the service. Stations should also be so laid out that any switch or section of high voltage bus and wiring can be cut out for repairs. It is not customary to duplicate low voltage switches or feeders, as these can be worked on alive. It is, however, good practice in larger installations to install a spare railway feeder panel on which any feeder may be thrown to facilitate repairs to circuit breakers.

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## ELECTRICITY AND MOVING-PICTURE MACHINES.

Insurance companies are paying some attention of late to the hazards of moving-picture machines, on account of fires that have occurred from this source. Those devices operated electrically are considered the safest. The arc is maintained by means of carbon pencils as in an ordinary arc lamp. Both direct and alternating currents are used for this purpose. The following suggestions are offered by the underwriters for the installation of the machines operated by electricity:

**Appliances.**—The knife switch, fuses and resistance coils should be substantially and securely mounted as far from the film-magazine as practicable, so that in the event of an arc occurring at switch-blade contacts, or should the enclosed fuse—which is the only type allowable in connection with this outfit—inadvertently burst through the cartridge and throwing out melted metal, or again, should heat of undue intensity be produced by the regulating coils connected in circuit with the arc lamp, there will be no danger of either the film taking fire or of excessive heat having any effect upon the contents of magazines. The bases of the knife switches should be mounted on slate or marble, and have at least four supporting screws. Measuring on surface of the base, there should be at least one-half inch space between head of screw or washer and nearest contact. The current-carrying wires should be soldered to switch terminals, whether the switch is furnished with lugs or otherwise, as this method gives a safer and more satisfactory contact. The construction details of knife switches are set forth in the National Electrical Code and must be closely followed.

**Switches** must be so arranged that the opening of the switches will cause all wires attached to them to become disconnected from main service, and furthermore, must be installed in an easily accessible place. Single-pole knife switches used for this purpose will not be tolerated by insurance inspection departments.

**Cut-out Blocks** must be so designed that it will be impossible to place any fuse of a given class into one which is intended for a current or voltage lower than that of the class to which the fuse is standardized.

**Fuses** must conform in every respect to the measurements given in the table of dimensions appearing in the National Electrical Code Details of Fittings. If cartridge fuse block is set within a metal enclosure, the surrounding atmosphere must not rise to a greater temperature than 125 degrees Fahrenheit without melting the enclosed fuse. It is well to remember that the rated capacity of fuses so installed must not exceed the attainable carrying capacity of rubber-covered wire.

**Resistance Coils,** where necessary, should invariably be stationary and isolated from inflammable material. They must be treated as sources of heat, and as such will often require the placing of a suitable heat-resisting material between the device and its surroundings. This may be accomplished when installed within metal box if the coils are rigidly suspended from top of booth at rear, and further protected by securing several plates of tin or sheet-iron around coils with an air space between, taking care that this protection is insulated from the framework, for which purpose the entire resistance box and air plates should be mounted on a slate or marble tablet before being secured to booth. In other words, the attachment of the separating material to its support and to the device must be independent of each other, and this separating material must be continuous between the device and the support; that is, the use of porcelain knobs will not be acceptable. Therefore, the arc-lamp outfit must only be furnished with such regulators as are enclosed in a properly ventilated non-combustible material. As a reminder, it may be well to add that incandescent lamps must not be utilized to this end.

**All Wire** employed within booth, for whatever purpose, must have an approved slow-burning insulation and secured in place entirely on insulating supports; that is to say, no portable cord will be permitted within booth unless it is pertinent to a proper connection to the lantern itself.

None other than a competent electrician should be allowed to make an attempt to install the equipment above described, as a majority of fires in the past have occurred from approved devices and material being installed by inferior workmen.

There is much prejudice against both magazines and film boxes, the latter employing an open mechanism with sprockets, and reel hangers attached to winding crank, the film passing into a large metal receiving box, for the reason that the film, while being rolled on the take-up reels, will often generate static electricity and cause sparks to ignite film. Hitherto it has been assumed that this frictional disturbance was encountered only in cold weather, but the late experience of several operators has tended to show that some recent fires, which would not formerly have been attributed to static electricity, have been caused by a static spark during the hot season within a poorly ventilated enclosure. To prevent trouble from this source, an electric neutralizer could be installed in connection with the outfit at minimum cost. The device is simple, can be attached to wall outside of booth and wired from there to the inductor-bars, which can be arranged near the film-reel. The principle, well known to electricians, is that of a possible static charge selecting from a pre-arranged neighboring current the small but exact quantity of electricity to neutralize itself.

## ELECTRIC CONDUIT FOR STREET RAILROADS.

By C. H. Stut.*

It may be well to state first a few of the differences between the old trolley and the electric conduit systems. First, the conduit does away with the objectionable trolley wire and poles, replacing them by conductor bars placed under ground. This is the main popular advantage of the new system, and constitutes its most potent departure from the old. Also a difference of great importance is the fact that there is no ground return in the underground system, the conductor bar carrying the return current, being insulated identically as is the bar which brings the current from the power house. In this way injurious electrolysis of pipes lying in the path of the return current is completely done away with.

The first requisite for a conduit railway is a continuous tunnel or conduit below the surface of the street. This makes the installation of the railway, in general, an undertaking of great magnitude, for it necessitates the building of the conduit and depressing or removing all pipes crossing its path. But in a city like San Francisco, where many cable roads are already in existence, the conditions are ideal, excepting only the sometimes impossible steepness of the hills, for the cable conduits can, with proper modifications and the addition of new hatches, manholes, electric appliances, etc., be made to serve the purpose of the electric conduits.

According to the plans drawn for the proposed Geary street line, the realization of which was rendered impossible by the earthquake and fire of last April, its construction would have embodied these features as far as the converted cable road could be used. This was possible from Kearney street to Golden Gate Park. The remaining distance is sparsely populated, so that there would have been no serious obstructions in the pathway of the conduits.

The arrangement of the essential parts of a conduit railroad is well shown by the plans for that road. The conductor bars are made of steel, with a T cross section. Each bar is 30 feet long and weighs 7½ pounds to the linear foot. The center of the bar is 15 inches below the top of the slot rail. It is necessary that they be placed low in the old cable conduits, because of the slight slant in their sides. The insulators must necessarily be long in order to give the bars the proper clearance from the sides of the conduit. The insulators support the bars every 8 feet by means of cast steel clips, which are attached to the ends of steel posts, forming the core of the insulator. Where the ends of the bars butt together these clips are made double so as to grip both ends. Although the supporting clips form an electrical bond, no reliance is placed upon them to carry the current. Two copper conductors are used, each equivalent to No. 0000 copper wire, and great care is taken to make a good contact with the steel bars. Each bond terminates in a copper plug, which is seven-eighths inches in outside diameter and exactly fits a corresponding hole. This plug is drilled with a ½-inch hole, into which a tapering steel plug is driven and clinched over, and the whole joint sweated absolutely water tight.

The insulator is one of the most important features of the whole installment, and many difficulties were experienced with different types when electric conduits were first introduced. It must combine great strength with good insulating properties. A satisfactory type is one composed of a cast iron cup bolted with two lugs into the slot rail. The construction necessary on the converted cable conduit is slightly different from this,owing to the different formation of the old slot rails. Rails specially designed for the service have a lower lip to bolt the insulators to and an upper lip to prevent water from dripping down on the bars and insulators. Inside the iron cup is inserted a hollow porcelain cylinder inbeded in cement. The steel core above mentioned screws loosely into the porcelain and is also held by cement. This combination of steel, iron, cement and porcelain gives the required strength.

The current is taken from the conductor bars by means of the plow. This is a device not unlike the cable grip in general appearance. It consists essentially of two shoes and a steel frame, carrying the copper connections from the shoes to the controller in the car above. The copper connections are properly insulated and are of sufficient size to carry the necessary current for the car. The shoes are of cast iron and are held in contact with the rail by flat springs. The San Francisco cable roads had two types of grips, namely, center grips and side grips. With the side grip type the slot is not in the center of the track. When this grip an slot arrangement was used in combination with a turn table terminus, as in the old Geary street road, the slot on both up and down track was nearer the inside rail. This construction necessitates a plow that is suspended in such a way that it can shift from side to side on the truck of the car, so as to accommodate itself to the slot. To effect this side motion of the plow it is hung on bars that run across the truck of the car, and the flexible copper connections allow the necessary lateral play. These plows are not heavy, weighing about 35 or 40 pounds, and can be easily taken up through the plow hatches provided for the purpose. The plow hatches are located at convenient places and are so arranged that the plows can be directly pulled up, the hatch opening as the plow is pulled out. The power house and car barns should be so located that the cars can run in and out by gravity, and also go in or come out from either track. In this way the turn-out need have no conduit, and it is necessary that the plow be lifted before taking the turn-out.

The hatch consists of a cast iron frame, which butts up against the slot rail, and a steel cover reinforced by a web riveted on the bottom. The tops of the rivets should be large, to prevent horses from slipping on the cover.

The conductor bars will be fed with current through feeders every two or three thousand feet, as the service requires. These feed wires will tap from the feeder mains, which run parallel to the track in ducts. These ducts are made of vitrified clay and have remarkably good insulating properties. Ducts made of iron and steel lined with cement have been tried, but the best results are obtained from vitrified clay. The sections are three feet long and the joints are made water tight. The ducts are placed 24 inches below the surface of the street and six feet three inches from the slot center. At every block there is a duct hole, through which a man can inspect or repair the duct and feeders. These duct holes have frames and covers similar to those of the hatches described above.

In order to keep the conduit free from water it is necessary to have numerous sewer connections. At each connection there should be a cleaner hole so that the run way can be kept open. The water should be taken out as fast as it flows into the conduit slot. The troubles that arise from water in connection with the conduit system are due to poor sewer connections rather than to any fault of the system. The amount of rain water that can enter the conduit through the slot is comparatively small and can be easily drained off through proper connections, and only bad sewers will occasion flooding of the conduit.

Street crossings offer the most complications in the conduit system. In crossing a cable road the conductor bar must be cut. The electrical bonds are carried under the cable, which generally runs low enough to clear the plow. If it does not, it must be depressed when the plow is crossing. At making and breaking the circuit on a cross-

*From the "California Journal of Technology."

ing, flashing occurs, and this is an evil which apparently cannot be done away with.

Special yokes are designed to carry the tracks at a crossing. These are similar to the ordinary yokes, but make a 45 degree angle with each track. In this way two larger yokes placed obliquely serve the purpose of four smaller ones. At the crossing of the rails there is heavy pounding of the wheels and to meet the wear consequent to it, removable castings of the hardest steel replace the rails for a few inches.

Where there are switches and the road branches as at a terminus, complications also arise. At such a place conductor bars must be broken and properly placed to prevent interference with the shoe. Special yokes and frames are also designed to carry the branching track and all the regular forms of conductor bars, manholes, etc., must be departed from.

The rails used are nine inches high and weigh 36 1-3 pounds per foot, and the yokes are placed five feet apart.

The conduit is covered on each side by sheet steel, then the concrete is filled in up to the top of the flange of the slot rail.

It is of the utmost importance that the yokes, rails, slot rails, insulators, conductor bars and all their fastenings should be of the very best material and workmanship throughout. The different items that are built in and about the conduit, in combination with the concrete, form the support for the heavy cars and all other heavy traffic that must pass every hour of the day, must of necessity be entirely rigid and unyielding to any such wear and tear and temperature changes that occur year in and year out, for the very life or death of this system depends on this construction. If substantial and good it will subsist, but if it is of inferior material and construction it will soon give way and lead to very costly repairs or reconstruction, which might endanger the system and bring it to financial ruin.

## CAR AND LOCOMOTIVE OUTPUT IN 1906.

Official returns from the 38 car-building companies on the North American Continent (estimating two small plants not heard from), give the total number of railroad cars built during 1906 as 243,670. This includes subway and elevated cars, but does not include electric street and interurban cars. In addition to this total, the railroads have built in their own shops a large number of cars, both freight and passenger, but no estimate has been made of these. Of the manufacturers' output, 240,503 cars were for freight service, and 3,167 for passenger service; 236,451 were for domestic use, and 7,219 for export. Canada built 7,059 freight cars and 83 passenger cars, and Mexico built 203 freight and 6 passenger cars. The increase in the Canadian output over last year is 230 per cent. All of the builders have shared alike in the tremendous increase. A number of the companies reported this year the number of unfilled orders on their books. Most of them have more cars on order than they have built during the entire year, with their plants working at their maximum capacity. This is the best indication of the enormous demand for rolling stock and the utter inability of the railroads to get the cars they need.

The following table shows the "Railroad Gazette's" compilation of the number of cars built during the last eight years; totals for 1905 and 1906, including Canada:

| Year | Freight | Passenger. | Total. |
|---|---|---|---|
| 1899 | 119,886 | 1,305 | 121,191 |
| 1900 | 115,631 | 1,636 | 117,267 |
| 1901 | 136,950 | 2,055 | 139,005 |
| 1902 | 162,599 | 1,948 | 164,547 |
| 1903 | 153,195 | 2,007 | 155,202 |
| 1904 | 60,806 | 2,144 | 62,950 |
| 1905 | 165,455 | 2,551 | 168,006 |
| 1906 | 240,503 | 3,167 | 243,670 |

The locomotive output is quite as phenomenal. The twelve builders in the United States and Canada turned out 6,952 locomotives during the year, of which 6,232 were for domestic use and 720 for export. This is an increase of 27.3 per cent. over last year's total of 5,491. These figures do not include locomotives built in railroad shops, or locomotives rebuilt or repaired. There were built 237 electric locomotives and 292 compounds, as against 140 and 177, respectively, last year. The Canadian output was 217. The following table shows the number of locomotives built during the last 15 years; totals for 1905 and 1906, including Canada:

| | | |
|---|---|---|
| 1892.....2,012 | 1897.....1,251 | 1902.....4,070 |
| 1893.....2,011 | 1898.....1,875 | 1903.....5,152 |
| 1894..... 695 | 1899.....2,473 | 1904.....3,441 |
| 1895.....1,101 | 1900.....3,153 | 1905.....5,491 |
| 1896.....1,175 | 1901.....3,384 | 1906.....6,952 |

The cost of cars and locomotives has increased considerably during the year. Estimating the average cost of freight cars at $1,050, the total spent for freight cars amounts to $252,525,000. For passenger cars at $8,000, the cost was $25,336,000, and for locomotives at $14,500, the cost was $101,384,000. The total amount spent by the railroads for new rolling stock and motive power thus approximates $380,000,000, an increase over last year of about 45 per cent.—Railroad Gazette.

## A LIGHT DIFFUSER.

Everyone working at the bench, desk or drafting table likes to have plenty of light, but as the direct glare of sunshine is intolerable, it is generally necessary to screen off the light of windows on the sunny side of the building with shades or ground glass so as to subdue and diffuse the light and thus relieve its intensity. Unfortunately this usually means that a large part of the light is shut out. A scheme which subdues and diffuses the light without greatly reducing its volume was described by Mr. W. J. Thompson at a recent meeting of the Illuminating Engineering Society in New York. He hangs a large sheet of tracing cloth over the windows; the light coming through the tracing cloth is apparently as bright as the direct sunlight, but it is diffused, lighting up a room in very much the same manner as an ordinary skylight. He tried the tracing cloth scheme after trying to get proper illumination in other ways, using screens, awnings, shades, etc., but has found that the tracing cloth shades answer the purpose the best of all. The hint is one well worth consideration in the drawing room and is a scheme easily tried, as the material is always at hand for a trial. It may be that the simple tracing cloth scheme answers the purpose for which expensive prismatic glass arrangements are often insalled; that is, to throw light to the dark side of a room.

## TRADE NOTES.

It was announced at the Officers' and Branch Managers' Convention of the Crocker-Wheeler Company, held January 23 to 26, at the main office and works, Ampere, N. J., that the company had done more business during 1906 than any other year since its foundation eighteen years ago. As usual the personnel of the company was almost exactly the same as at the previous annual convention. Among the specialties that have brought phenomenal success to the company during the year, are alternating current generators of large capacity, direct current motors for machine tools and for all other kinds of machinery, the celebrated W type rolling mill motors, transformers and induction motors.

## LIGHT.*

By W. R. Whitney.

It is the writer's intention to briefly review the present schemes for the production of light by electrical means and to consider the possible future limitations; to look into present efficiency compared with what we may hope to obtain. In other words, to follow along the lines of thought which the experimenter in this subject naturally follows.

A definition of light might at this point be desirable, but the attempt at best would only result in jumbling a few words together which might satisfy the present knowledge of it, and even then would not give as good a conception of light as we all have. We know it as that agency by which we see. It is a something which affects the retina of the eye possibly somewhat as it affects a photographic plate. In modern times it has been recognized as a form of radiant energy, derived from a source such as the sun, and carried in waves or periodic vibrations through space with a velocity of 190,000 miles per second. In scientific parlance, it is the result of waves of electromagnetic induction in the ether by transverse oscillatory movements of electric charges. But until the luminiferous ether is defined and an electric charge understood, we cannot expect to see it in this way. Accepting this statement, we may simplify it by saying that light is due to energy in space, the energy being in wave form through space. The velocity of propagation of this energy is the same no matter what the size of the wave, so that we may have all wave lengths passing with equal velocity through space and produced by the same general means. The energy will differ only in wave length and frequency. That part of such energy which has wave length varying from 16 to 24-100000 of an inch constitutes light. This is merely because within these limits our eyes are sensitive to the energy. Millions of times greater and smaller waves also exist. The longest ones, such as those of several feet or even much longer, are the ones which, so to speak, are the light to the wireless telegraphic receiver, i. e., they are the wireless waves. The very small ones are only detected by photographic plates, by phosphorescent phenomena, etc.

By causing a motion of electric charges within a circuit of visible dimensions, Hertz, the real father of wireless telegraphy, found that he could produce ether waves with lengths of several feet. It was later shown that they could also be similarly produced with lengths less than an inch. The short waves which give us the sense of light are so small that they could only be produced by the motion of electric charges in ultramicroscopic circuits or in those of the magnitude of atoms or molecules. Thus our methods of producing light are all apparently connected with intromolecular or atomic electrical phenomena.

The radiated energy from the sun is, generally speaking, mostly heat waves, i. e., mostly of longer wave length than the light waves. One might imagine a sun giving off relatively the same light, but much less heat than does our sun. It is this relationship between the heat and the light emitted by any source that determines its light value or light efficiency. A solid body at a temperature of dull redness produces the waves which we call heat without giving much light. The waves are a little too long. As its temperature is raised the light becomes more intense, but more heat is also emitted. As we thus continue raising the temperature, however, the fraction of energy sent off as light increases and the light economy improves. The average wave length is shortening. We would expect that by still further raising the temperature, the body might give neither heat nor light, as it might then emit only such short waves as are beyond our perception except by photography or some other external means. In practice, however, this point is not reached, because the heated body is first destroyed or vaporized. Evidently in attempting to get artificial light we must aim at producing as nearly as possible only the waves of the prescribed length, 16-100000 to 24-100000 of an inch. This has not been done to any great extent as yet; that is, all practical sources of light still send out much more than half the energy as useless heat. In other words, there is plenty of room for improvement in light sources.

To those who are interested, but have not given the point much thought, it may be worth while to show how a knowledge is gained of the actual fraction of applied energy which in any luminous source is obtained as light. One method which seems quite simple, consists in immersing the light in a known quantity of water in a vessel the walls of which may be made transparent or opaque at will. When opaque, the entire energy sent to the lamp ultimately enters the water and raises its temperature at a definite rate. This rate is less when the walls are transparent, by that quantity of energy which escapes as light. The relationship between the loss through the transparent walls and the total input is the "efficiency." An incandescent carbon lamp so tested would show that not over 5 pre cent. of the energy used is emitted in visible form.

The energy of the light which falls upon a black body is all used in heating the body, so that such a body interposed in the path of the light wave after these had been separated from other waves into a spectrum, would form a calorimeter informing us at what rate light energy was being sent to it from the light source. Knowing the total heat value of the light process, for example, the combustion of the oil, we can thus also readily determine its light efficiency. In this way an oil lamp may give about 3 per cent. of the energy of the combustion as light. An electric arc light may be as high as 40 per cent.; consequently there is here a wide margin which permits of oil engines being used to generate mechanical energy, which in turn is transformed by electric generators and used for lighting purposes instead of simply burning the oil in lamps for the same purpose. And this is true in spite of the fact that each such transformation turns a part of the energy into heat.

The various ways of producing light by electrical means may be divided into three classes. Solids heated to incandescence by the passage of the current. Vapors so heated and a combination of both.

The first type is best illustrated by the various kinds of incandescent lamp. The most common are the well known Carbon filament lamp, the Nernst lamp in which a filament of metallic oxides incandesces and the newer vacuum lamps having osmium, tantalum or tungsten filaments.

In this type of lamp it is of the greatest importance to operate it in such a way as to compromise between its practical length of life and its efficiency. This can best be illustrated by a rough experiment which consists in operating an ordinary carbon lamp at very much higher than its rated voltage. Under these conditions its efficiency is very greatly increased but the so-called useful life is less the higher the efficiency. In practice, carbon incandescent lamps are operated at an efficiency of about 3 watts per candle power, and at that efficiency they fall in luminosity to 80 per cent. of their original value within 500 hours. This 80 per cent. point is considered the death of the lamp—that is, the end of its useful life. It might last much longer, but would be continually giving out less and less light. If the same lamp is run at an efficiency one-third greater, in other words, at 2 watts per candle power, its useful life will be only about 50 hours. The efficiency then, that is to be practically preferred is determined by the relationship between the cost of energy and the cost and trouble of installing fresh lamps. This is what has determined the present running rate of the carbon incandescent lamp. The general principles in this case also apply to other filament lamps, so that they are all operated at such voltage as shall make the final cost for the light the least possible.

The mercury arc lamp and such vapor lamps as Geissler or Crookes tubes are representatives of the second class; here there is no consumption of material and the luminosity is due

*From the Sibley Journal of Engineering, Cornell University.

to the incandescent vapors. Another type of incandescent vapor lamp is the magnetic arc lamp in which the vapors of iron or its oxide are heated to incandescence between electrodes, one of which contains the iron or other luminous material which is gradually fed into the arc by the current.

The ordinary carbon arc and the flaming carbon arc are combinations of the two previous types. In the former the light almost entirely emanates from the so-called crater or tip of the positive carbon electrode, the actual arc or path of the current between the electrodes being almost non-luminous. The flaming arcs which are made most familiar to us by the brilliant reddish and powerful lamp occasionally seen on the streets owe most of their lighting power to the vapors of salts, such as calcium fluoride, which are contained in the carbon pencils. A large part of the light in this case also comes from the heated surface of the carbon electrodes.

As there are more incandescent carbon filament lamps made than any other kind, it may be interesting to briefly consider the present process of manufacture. The history of Mr. Edison's experiments, in which all possible sources of filaments or fibres or carbon were tested, are probably well known. In the past carbonized silk, bamboo, paper, cotton and various fibres have been used. The present filaments are usually made from some soluble modification of cotton. The solution is squirted through a die, much as a spider spins a web. The fibre is then hardened by water or alcohol. This is also the common practice in the manufacture of artificial silk. The fibres, made as described, are wound on metal forms to shape them and finally slowly baked until only carbon is left. This is finally heated to a very high temperature in a gas furnace. Such a filament, however, when mounted in an evacuated globe in the usual manner, lasts only about 175 hours at 3 watts per candle. The lamps of today, however, last 500 hours. This considerable difference is due to a coating of graphite which is put upon the carbon filament before it is mounted in the lamp. This coating is an exceedingly delicate process and consists in heating the filament to a very high temperature while in a vapor of benzine or other hydro-carbon. Here the filament not only cannot burn, but it decomposes the benzine vapor and causes carbon as graphite to deposit upon its surface.

In general, the light efficiency of a heated solid increases rapidly with the temperature. For example, an isolated body at a temperature below 500 degrees C. is radiating all its energy in non-visible form. At a dull red heat only a small fraction of 1 per cent. of the applied energy is in the form of light. At about 1000 degrees perhaps 1 per cent. or 2 per cent. is as light. At 2000 degrees it amounts to about 10 per cent.

In all electric lamps, then, the great need is for a substance which shall operate at very high temperature. The temperature which the material will withstand is the limiting feature of all electric lamps, both arc and incandescent. Where carbon is used the temperature is limited by the vaporizing of the carbon. In the case of metal filaments the limit is determined by the melting or softening point of the metal used. It is natural to speculate on the future possibilities of incandescent lamps under these conditions. There is really no reason for supposing that the most stable substance possible has yet been discovered. It is evident that through still higher temperature ranges, the light efficiency will continue to rapidly increase, although it will be later shown that this does not continue indefinitely.

The carbon filament may be run for a few moments at so high a temperature that its light efficiency corresponds to about .4 of a watt per candle power. This is eight times as efficient as its normal operation and possibly corresponds to about 50 per cent. light efficiency. On this basis a hundred per cent. efficiency would correspond to about .2 of a watt per candle. This value includes so many errors that it is not to be looked at as more than a limiting upper value. It also involves the exclusion of what is called selective radiation. In other words, it is based on the so-called black body luminosity.

The carbon lamp at .4 watt per candle is running at a temperature approximating 3500 degrees C. This is above the melting point of any other known substance, although experiments are continually being carried on along the lines of discovering more stable bodies. The carbon filament at ordinary operating efficiencies,—about 3 watts per candle, is at a temperature not far from 1700 degrees C., while the metal filaments, such as osmium and tantalum, probably run between 2000 and 2200 degrees. It is interesting to know that if the carbon filament could be made to withstand for 500 hours the temperature which it bears for a few moments at .4 of a watt per candle, then the cost of operating incandescent lamps would be reduced to nearly 1-10 of the present rate.

In the case of the tungsten lamp this difference is still more marked. This lamp will burn at 1¼ watts per candle for over 500 hours and is, therefore, three times as efficient as the ordinary carbon; but it will also last a few moments at about .2 watts per candle. If it could only be permanent at this point our lighting would be about 5 per cent. of the present cost.

Naturally, the number of elements or compounds which will be stable at temperatures above 3000 degrees is small, but the chemist recognizes that little is known about the chemistry of substances at these temperatures and, therefore, this field must be gone over carefully. Reasoning purely from analogies in nature it would perhaps seem now more normal to experiment with arcs and vapors than with incandescent solids, for astro-physics teaches us that the materials which are withstanding high temperatures are in gaseous state. There seems to be no theoretical difficulty in introducing any desired quantity of electric energy into a given space. Therefore it ought to be possible to finally produce nearly one hundred per cent. light efficiency by a suitable discovery of material.

It is very interesting to note that the work of Sir Norman Lockyer discloses the existence of temperatures in the stellar space which are much higher than that which would probably correspond to 100 per cent. light efficiency—that is in producing light by temperature-rise we may go too far. Light efficiency does not continually rise with temperature and as the average wave length of the radiated energy gets continually shorter with rise of temperature, it may become so short as to be in invisible form. The 100 per cent. illuminant would send all of its energy into the visible spectrum and this is not true of any known illuminant. In all practical cases much energy is radiated in waves too long to be in a visible spectrum; that is, the body sends out infra-red waves. Spectra photographs of many of the stars have shown that most of their energy is in the ultra violet end of the spectrum. Over measurable temperature intervals relationships have been discovered between the total energy radiated and the temperature of the body, and also between the wave length corresponding to the maximum energy in the spectrum and the temperature of the body. As these regularities are practically laws within our known range of temperatures it is natural that attempts to measure the temperature of the stars should have been based upon them. In this way Lockyer has determined the temperatures of the stars ranging all the way from 6000 degrees C. to over 25000 degrees C.

## ABOUT RAILWAYS.

In Great Britain you find both the cheapest and most expensive miles of railway ever constructed. The eight-mile line known as the Wotton tramway, and which was built to the order of the late Duke of Buckingham and Chandos, cost only £1,400 a mile. It is of standard gauge and is now used as a light railway.

The most costly piece of railway line in the world is that between the Mansion House and Aldgate, on the Underground, London. It cost nearly £2,000,000. Between Trinity Square and King William statue the record rose to no less than 1,000 guineas a yard, about £30 an inch.—London Answers.

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# EDITORIAL.

**Engineering and Business as a Profession.**

There can be no question that the work of the engineer has been of the greatest importance in the development of the country. Engineering as a profession has become well recognized, and our universities have given a great deal of attention to the organization and development of technical courses to properly train young men to become successful engineers, and it is worth while to consider the real position which the engineer of today occupies in connection with the many enterprises of gigantic magnitude which are being planned and constructed all over the country. It is generally conceded that a man thoroughly trained and experienced is a necessary factor in all engineering enterprises. Nevertheless the reward of the painstaking and successful engineer is small as compared to that of his brother in business. As new processes are developed and thoroughly understood, the demand for the engineer becomes less. If it were not for the continued progress in scientific and engineering matters, it is possible that the details of engineering enterprises would become so thoroughly understood that new appliances and installations would be but duplicates of those preceding.

It is of course true that the engineer is but one factor in our great system of commercial and financial affairs. It is probably also true that many engineers confine their attention too closely to technical details rather than to general principles. It is perhaps but natural that every one who has spent the greater part of his life in significant processes of development, has been personally influenced by this into a particular and rather restricted method of thought. It is but natural also that such persons will have an exaggerated idea of their own importance as compared with the importance of others, whose work is also a part of the general scheme.

After a young man completes the technical courses of a good engineering school, it is quite necessary for him to have his point of view materially modified before he is in a position to fully appreciate the importance of other than purely technical details. It is noticeable that young college graduates, as well as the majority of young workmen, are especially interested in some modification of familiar processes, some shop kink or detail of construction when they have an opportunity to inspect a large manufacturing plant. It is quite evident that they have little concern for such important matters as the source of raw materials, their cost, the character and peculiarities of the manufactured product, its probable destination and use, the successful sale of the apparatus and particularly the system of handling not alone the materials of construction, but also the employees from the highest official to the least important assistant.

As soon as the young engineer, no matter what training he may have had, begins to take an interest in commercial matters, as well as in the technical details, it is remarkable to notice how the broader point of view improves his general ability. He sometimes finds that the technical details in his own mind have shrunken into comparative insignificance and that the commercial side of engineering seems more and more important.

Men of affairs often criticize engineers, saying that as a rule they are too much absorbed in technical matters and neglect almost entirely the administrative and business features which are undoubtedly of the highest importance. It is often remarked that few engineers have thus far become men of affairs, in other words that the supreme power does not rest in their hands. It is undoubtedly true that the feeling exists, principally among financiers, that the training of the engineer necessarily impairs his capacity to become a leader and be responsible for the financial success of large industrial enterprises. It is nevertheless true that within recent years many engineers have risen from modest ranks to the highest administrative positions. These men have not minimized the importance of thoroughly mastering technical details, but they have modified their earlier points of view and taken pains to inform themselves regarding administrative details, the necessity of successfully handling employees and the general management of other details, whether connected with the engineering or business side of the enterprise. With properly directed efforts, the opportunities to reach the highest posi-

tions are very much improved by a thorough professional foundation, but the required technical training must not be allowed to direct the efforts into a restricted channel.

One cannot help being impressed with the fact that the board of directors of every corporation is concerned above all with the necessity of so conducting their business that in the end the balance sheet will be affected most favorably. The engineer has, and ought properly to have, the commercial success of the enterprise always before him. To the engineer are many times left decisions where the supreme consideration is safety and permanence, but he will best serve the great cause of industrial development if he aims to produce good results through good engineering.

The work of the engineer may be divided into two general classes; first, the erection or installation of permanent engineering structures, whether for private or public use; and second, that of producing articles or apparatus for consumption or use. In each the commercial side is of importance, but in the latter or in manufactures the dominating factor in every branch is the cheapening of the cost of production.

In the first class of work a decision on the part of the engineer may and often does materially affect the cost of the installation. The wisdom of such a decision can be pretty thoroughly investigated by the directors of the corporation taking the ultimate end to be attained into consideration. In the latter class of engineering enterprises, however, there are a good many reasons why the business management is of far greater importance than the engineering end, as viewed from the standpoint of the average stockholder or member of the board of directors. The natural fluctuations of the market make it possible for the manager to either save or lose large sums in the purchase of raw material. At the same time the engineering end of the enterprise may be laboriously cutting down the cost of manufacture. Probably in many cases the reduction of the cost of manufacture results in a saving for all time. Very few of those who are responsible for the financial management of such manufacturing concerns recognize that in the end such improvements in the methods of manufacture result in enormous savings, since at the time the reduced cost of construction is much less apparent than a saving due to a fortunate purchase of raw material or an opportune sale of the product of the factory. To the technical man it is most discouraging to have his efforts pass almost unnoticed when he greatly reduces the cost of production, and at the same time witnesses the abundant approval showered upon the manager.

It must be said that there are many brilliant examples of the clear headed men of affairs and the progressive engineer combined in a single individual, and it is this type of man who will more and more come to the front in engineering matters. But to reach this end, the trained engineer must necessarily familiarize himself and keep in touch with current events and developments in the financial world, and he must be and remain a close student of the great economic questions of the day.

Naturally the personality of the individual will always affect his choice of a profession. Seldom, indeed, will the inventor or investigator have the characteristics necessary in a general manager. But the number of men by nature and character of mind capable of being inventors or investigators of importance, are comparatively few, while in the present day the commercial development in this country has been so great as to require a large number of men of more or less ordinary ability who should succeed if they but study carefully existing conditions. The difficult problem of successfully handling labor is of increasing importance every day. It is to such matters that the engineer, who has a desire to work in the commercial side of his profession, should give his best attention.

The conducting of every business, large or small, depends for its success upon the closest study, not alone of the prevailing conditions, but a correct diagnosis of tendencies which may be modified or changed by local influences.

The men in whose hands all the greatest enterprises of today are placed are the men not only of foresight, but they are those who have in addition the ability, courage and imagination to shape affairs with reference to the future. They are men of thought and of action, who are more than financiers or general managers, and it must be said more than mere designing or operating engineers. There is no country in which this ability of the highest type is more liberally rewarded than in our own, nor has there ever been a time in the history of our country when men of this type had greater opportunities. In the commercial and industrial development of the nation, many serious mistakes have been made again and again, to which must be attributed not only the waves of prosperity, but also the periods of depression which surely follow and which have robbed every active man, from the laborer to the man of affairs, of years of his life as measured by his savings. If the future generations can receive the better and broader training which results in combining in a single individual the experienced engineer and the able man of affairs, it is not too much to hope that the future will witness a steady and safe, although less spectacular, progress.

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## MERCURY ARC RECTIFIER DEMONSTRATION.

The General Electric Company are arranging to give a demonstration of their Mercury Arc Rectifier at the Auto Show at the Coliseum, March 18th, San Francisco.

## THE CENTRIFUGAL PUMP.

By E. N. Percy.

There is no duty performed by a reciprocating pump at the present time that cannot be duplicated by a centrifugal pump, with greater commercial efficiency, and equal or less first cost; and with less weight of material, less volume of space occupied, and less floor space. This has not always been so, but it can be so, with correct designs. When it is desired to change the path of a moving object, a new force must be introduced. Whether the object be a railroad train, a projectile, fluid, gas or vapor, the change must be made gradually, the rate of change beginning at zero, rising to a maximum, and falling again to zero. The curved path of this change is treated with the same mathematics, whether it be a railroad, a steam turbine blade, or the vanes of a centrifugal pump; the number and size of said paths being the only difference. In turbines and centrifugal pumps, the path itself may move, introducing the element of relative velocity, as opposed to actual velocity.

Since the losses + output = power received, first will be considered the losses in a pumping plant of this type.

All loss may be summed up under five heads: First, those due to skin friction. At low velocities, with smooth castings, and good design, these losses are not worth considering; but narrow ports, rough castings, and unnecessary velocities may bring this one loss as high as 10 per cent. Second, those due to current friction, or the friction and eddying of one current against another. One current should never run opposite to another beside it, nor should it flow in any direction, except parallel with the adjacent currents, and at the same velocities. An instance of this is the discharge from the runner into the currents whirling in the casing. Third, shock and impact; those due to currents meeting, and wasting their energy on each other, or a current meeting a wall, and wasting its energy in swirls and eddies. Fig. 1 shows some of the losses thus incurred, by poor design. The diagram shows a style of runner largely used, under the mistaken idea that the immense port area of an open

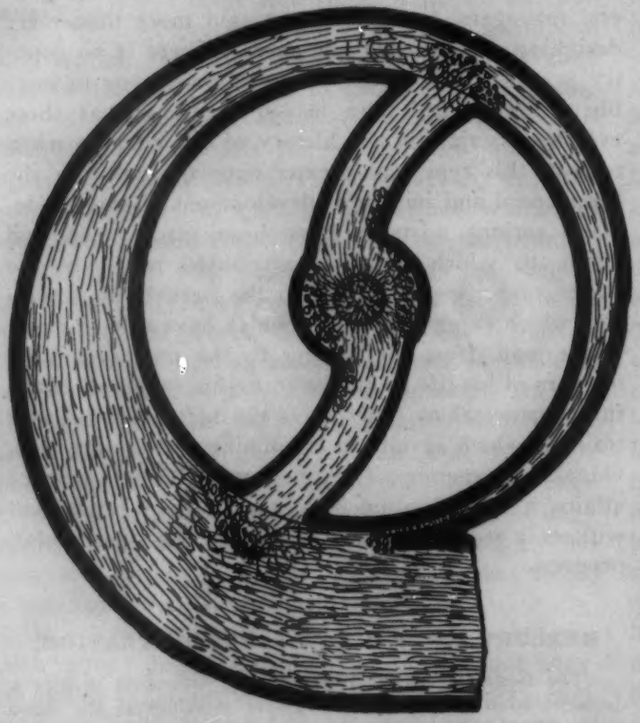


FIG. 1.

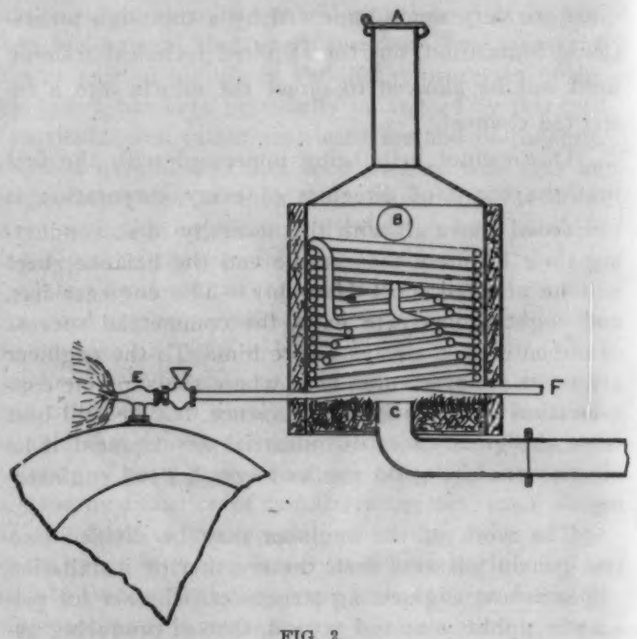



FIG. 2.

runner is unnecessary. The shock of impact of the suction on the inside of the vanes causes a loss that is serious, and the high velocity of the discharge into the whirl space, causes other shock losses. Fourth, water leaks around the runner are the source of quite a serious loss. Fifth, air leaks in the suction pipe, or at a suction stuffing box can cause the efficiency to drop 50 per cent., or even prevent the pump operating. Sixth, mechanical losses, from belts, bearings, couplings, bending of shaft, lack of alignment, lack of balance, runner rubbing on casing, etc.

Friction is a function of velocity, smoothness of castings and design.

Impact and shock are functions only of change of direction, therefore are controlled by design. All other losses are controlled by the design and workmanship.

Suction pipe losses belong to general hydraulics, but we will make a brief resume with particular reference to the centrifugal pump. As to when the pump can be placed below the water level, and when above it, the engineer must be the judge. The nearer the pump is to the water, or better still, if below the water level, the greater will be the efficiency; this does not demonstrate theoretically; but as air leaks are eliminated, and all of the duty is on the high pressure side of the pump, so many small losses are eliminated, together with the ease of starting, that considerable saving is made. However, if placed below the water level, valves, etc., must be provided to prevent flooding, when cleaning or repairing.

If the pump be placed above the water level, it must be primed in one of three ways, before starting. First, by having a foot valve, and filling the pump with water, either through the discharge pipe or otherwise. Second, by sucking the air out with a steam primer, or air suction pump. Third, by filling the pump with steam, and condensing it with a jet of water, thus drawing up the water for enough to start. All of these methods are satisfactory, but the steam primer is best; the steam primer, of course, is not available where a gas engine or electric moter is used. Fig. 2 shows a steam primer designed by the writer, which can be used anywhere, as it generates its own steam, and costs far less than an air suction pump, and is more rapid. The steam is generated in a continuous coil of ⅝ inch steel pipe, about two hundred feet long, and occupies less than a cubic foot of space. It is enclosed by an asbestos, or fire clay lined casing, and heated by a coal, charcoal, gasoline, or alcohol

fire, as is most convenient; the cost of the most expensive of these fuels, being nominal, to start the pump. No feed pump is necessary, as water from a service pipe, a tank on the roof, or the discharge pipe, will give sufficient pressure to operate the ejector. With an alcohol fire steam can be raised in five minutes and the pump primed in as much more time.

After starting, the apparatus may be disconnected, or it can be heated by the exhaust of a gas engine, entering through C, and exiting by B, first closing the ordinary uptake at A. This is absolutely surplus power; not enough to serve as additional power, but with the ejector, the suction can be improved, or a vacuum can be maintained in the lantern of the stuffing box, thus eliminating air leakage, which in itself is the cause of large efficiency losses.

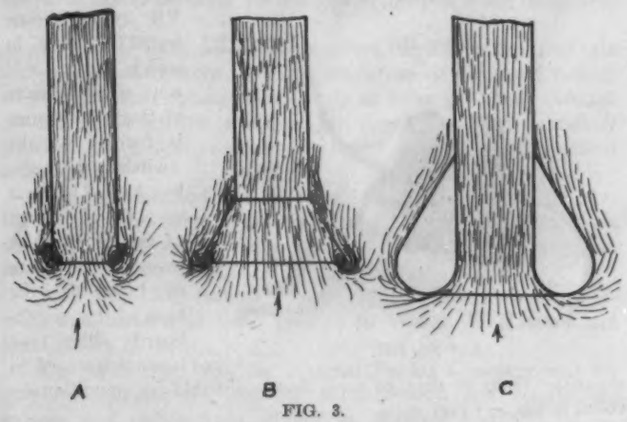



FIG. 3.

A suction valve at the bottom will often prevent the emptying of the pump between runs. Also, such a valve is under very little wear and tear with a centrifugal, as it stands open or shut; whereas with a reciprocating pump, it must rise and seat with every stroke. With high speed reciprocating pumps, the current of water is probably near continuous because of its own inertia, but it is certain that the foot valves of these pumps, in practice, show heavier wear. Strainers are hardly necessary, as a centrifugal pump can take any small objects, dirt, or grit, without suffering seriously, and large objects, grass and plants can be kept out with an ordinary grating, or grizzly cage around the pipe. If filtering or straining is necessary, it is better to do it on the discharge side of the pump, as the pump can work more efficiently, in case the strainer or filter is clogged.

In gradually bringing the water in the suction supply from a state of rest to the velocity of entrance, losses from eddying usually occur. These may not be large, but few losses in a pumping plant are large, and by the elimination of some of the small losses we get a large gain and obtain high duty. With an ordinary straight suction pipe, as in Fig. 3-A, the centrifugal force of the streams making the sharp turn around the edge of the pipe causes an eddy, throws the streams out from the edge, and contracts the available entrance area, making a higher entrance velocity necessary at the center. Under a lift of 17 to 20 feet, with a suction pipe designed for a flow of 150 feet per minute, this loss could reduce the efficiency 10 per cent. or more, for it would be impossible for the velocity at the center to increase.

Also, the current coming down the outside of the pipe is opposed to entering currents, and is most affected by the centrifugal force of swinging around the pipe edge, hence it contributes largely to the eddy.

With the bell mouth suction pipe, the eddy losses pertain the same, but the wide bell still leaves ample room for the water to enter, and gradually reach the velocity of flow in pipe, as in Fig. 3-B.

Fig. 3-C shows a suction bell designed by the writer, which eliminates eddies, allows of an easy flow from all directions, without sharp bends, and the water is gradually brought to the full velocity of the flow in suction pipe, and no contraction of area due to eddying takes place.

The pipe should be smooth, free from rivet heads, or other impedimenta, and as straight as possible.

All ells should have as large a radius as possible. Ells at the entrance to pump are very apt to have short radius. The effect is for the inertia of the water to carry it to the opposite side of the ell, see Fig. 4-A, and creating an eddy on the inside of the ell. This contracts the available area of passage, and at point X the water must run with increased velocity.

FIG. 4.

Fib. 4-B shows the double suction, with losses apt to occur here. First, the incoming stream strikes the rounded part of the pump casing, which could and should be sharpened at this point. Then, the eddies and shock losses under the stuffing boxes. The losses by striking the shaft are insignificant, even in a high duty pump, because the water is flowing nearly parallel to it, as a rule, and because it is small, compared to the stream, and lastly, it cannot be avoided in any reasonable way. At the inside of the stream, where it turns into the pump, is a serious loss, caused by the sharp turn, which allows eddying, contracting of flow area by centrifugal force of sudden turn in stream, and an uneven supply to the runner; less water entering on the under side than on the upper. Fig. 4-C shows a modern high duty suction entrance and runner, which eliminates all of the faults just mentioned, and guides the water easily and continuously through the desired changes of path.

When the suction is on one side only, when the pump is vertical, and in practice, with any pump, the pressures on each side of the runner seldom balance. As a result, some balancing force, thrust rings, or revolving piston must be used to hold the shaft in place lengthwise. This must be considered in placing the suction passages in the design.

A centrifugal pump bearing is a difficult proposition. A high speed, high duty pump must have outside bearings, separate from the stuffing boxes, and of the best possible construction.

Outside bearings would be of babbitt or brass, designed in accordance with approved practice, and lubricates as any high speed bearing. But when the stuffing box and bearing are combined, it is quite a problem to lubricate. A bearing made of lignum vitae wood, stood on end, will receive sufficient lubrication from the water itself, but such a bearing cannot be run very close, and wears badly. A long babbitt bearing, with compressed grease lubrication gives excellent satisfaction, particularly if the grease be pumped in, but this is seldom done. Nothing is more useless than a grease cup here, as the grease is never warm, and the bearing would be kept cool by the water, even though it were being cut to pieces. A jet of water is often used to keep grit away from the bearing.

The coupling up, etc., of the pump, and methods of running, etc., are all matters of ordinary mechanical design.

# INDUSTRIAL

## WAGNER TRANSFORMERS

The potential transformers manufactured by the Wagner Electric Mfg. Co. have been designed with a high factor of safety. They will carry their loads and maintain their strict ratio without any difficulty.

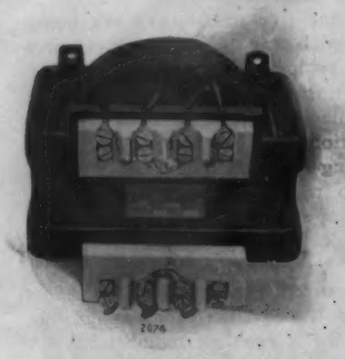
As standard practice, these transformers are manufactured in three different capacities—25, 50 and 100 watt—and are put out both in the dry and oil filled type. As ordinarily recommended, the dry type of transformers are used on voltages up to 2,400, the oil filled type of transformers starting at 2,500 volts and running up to 15,000 volts.

When these transformers were put upon the market, they were first brought out in the 100 watt type only, which in order to meet the demand of central station managers, were made suitable for operation on either 1100 or 2200 primary circuit, with voltage ratio of ten and twenty to one. That is to say, they could be connected by simply changing the terminal block connections as follows: 1100-110 volt circuit, 1100-220, 2200-110 and 2200-220.

This 100 watt type transformer is suitable for operating one or a combination of instruments. It has capacity, for instance, for the operation of a voltmeter, indicating wattmeter, integrating wattmeter, a power factor indicator, and a synchronism indicator. Some central station managers and switchboard builders have gotten into the habit of running switchboard lights from these potential transformers. This is a habit which we discourage, as a switchboard builder is too liable to overload the transformer if this is done. We therefore do not recommend same.

For smaller boards, boards which do not have the number and complexity of instruments listed above, we make a 50 watt transformer, both with and without interchangeable leads. This transformer has sufficient capacity for operating, for instance, a voltmeter and indicating wattmeter, and an integrating wattmeter.

For smaller installations, we manufacture a potential transformer with 25 watt capacity, suitable for the operation of a voltmeter. In this connection we might state that transformers for the higher voltages, that is above 2,500 volts, are made in the 100 watt capacity only.



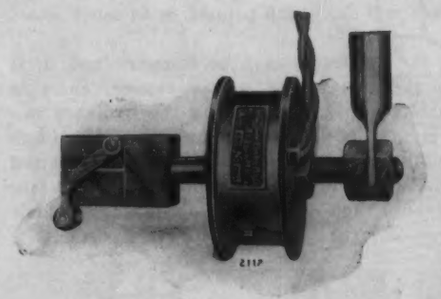
CUT NO. 2074

Our cut No. 2074 herewith shows a view of the 100 watt potential transformer, with the terminal boards and connections shown thereon. This is a very compact transformer, suitable for back of board mounting. It is so arranged that it is not easily deranged or put out of order.

Cut No. 2068 shows a 50 watt transformer with non-interchangeable leads, this cut showing a 2200-220 volt transformer.

Series transformers as ordinarily furnished are made in three standard capacities, 2 watt, 10 watt and 30 watt type. We manufacture these with primary capacity from 10 to 10,000 amperes, and suitable for operation on voltages up to 45,000 volts.

CUT NO 2068



CUT NO. 2117

CUT NO. 1037

The 2 watt type of transformer is manufactured in two different forms, an RA type, shown in cut No. 1037, this cut being the transformer with feet shown with a single primary lead; and an RB type, shown in cut No. 2117, in which you will note the primary of the transformer is formed by the switchstud or the bus bar. This is a very handy form of mounting, as it saves the drilling of holes in the back of the switchboard. This type is manufactured in capacities from 10 amp. to 1000, and is suitable for operation on voltages up to 6,600 volts.

CUT NO. 1011

Our type K 30 watt transformer is shown in cut No. 1011, suitable for mounting on back of switchboard. This is built in capacities from 10 to 10,000, and is suitable for operation on voltages up to 15,000. For voltages above 15,000, we furnish an oil type form of construction.

For one ammeter we recommend our type RA or RB 2 watt transformer. For an ammeter with indicating wattmeter or integrating wattmeter, we recommend our type FA 10 watt. For an ammeter, indicating wattmeter, integrating wattmeter and power factor indicator, we recommend our type K, 30 watt.

We do not recommend the use of these series transformers with instruments and the solenoid of oil switches in combination, as we have found that the iron in the solenoid changes the phase relation of the secondary current in the transformer, producing an error in the reading of the wattmeter.

Other types of transformers, both in the potential and series transformer, are built on special orders as needs develop.

## PRICE OF ILLUMINATING GAS IN ENGLAND.

Consul F. W. Mahin reports that the price of illuminating gas in Widnes, Lancashire, England, is now 32 cents to small consumers, but will be reduced to 30 cents on July 1st. Large consumers will pay from 22 to 26 cents. This is claimed to be the cheapest gas in the world. The town has about 30,000 population. The price of gas is remarkably low everywhere in Great Britain, whether under public or private control, the general range of price being 40 and 70 cents.—Scientific American.

## HASSAM PAVEMENT.

The city of Worcester, about ten years ago, began the laying of granite block pavement on a concrete base, filling the joints and flushing over the surface of the granite blocks with a grout of pea stone and Portland cement. This top coat was only about one-eighth of an inch thick over the surface of the blocks. It was found that for five or six years this pea stone and cement top sustained all the wear without chipping or wearing through. This pavement was very satisfactory, but the cost was large, and in the endeavor to find a pavement which would combine the advantage of this grouted block and yet could be laid at less cost, it occurred to Mr. Hassam, who was at that time street commissioner, that it was an unnecessary expenditure of money to have the stone cut into rectangular blocks and placed one at a time by high priced labor, and he determined to see what could be done by the use of broken stone compacted by rolling.

In April, 1905, he paved a street, laying a depth of six inches of broken stone, pouring the grout of Portland cement over it and then rolling immediately to force the grout through all the voids of the stone. This street was very carefully watched for a year, and it was found to give most excellent satisfaction.

The same method was tried for foundation work under paving during the same year. It was found by this process a denser concrete was formed, requiring less cement and saving an immense amount of labor.

May 1st, 1906, patents for the laying of the above pavement and foundation were granted to Walter E. Hassam and Dr. Charles K. Pevey.

On June 13th, 1906, the Hassam Paving Company was incorporated under the laws of Massachusetts and bought the patents and rights from Walter E. Hassam and Charles K. Pevey.

The following officers were chosen:

President, Walter H. Blodget; vice-presidents, George D. Webb and Charles K. Pevey; secretary, George T. Dewey; treasurer, William D. Luey; managers, Walter E. Hassam and Claude A. Magill. Offices were opened at 311 Main street, Worcester, Mass., and the company began doing contracting for the Hassam pavement and foundations.

Since that time 115,440 square yards of concrete foundations have been contracted for and 74,723 square yards of the Hassam pavement complete have been laid in twelve cities in the New England states.

Branch offices of the Hassam Paving Company have been opened at 15 William street, New York city, and the Monadnock Building, San Francisco, Cal., and licenses have been granted for laying the Hassam pavement and foundation to the Simpson Bros. Corporation, 166 Devonshire street, Boston, Mass.; the Powell Paving Company, 107 St. James street, Montreal, Canada; the Northeastern Concrete Paving & Construction Co., of Portland, Me.; the Rackliffe-Gibson Construction Company of St. Joseph, Mo.; the Inter-State Paving Co., of Utica, N. Y.

The Hassam pavement, consisting, as it does, entirely of mineral matter, has nothing in its composition to disintegrate by the action of water, oil or acids that may be formed upon the street, and becomes harder for several years after laying. The surface resembles that of a macadam street, excepting that all voids between the stone are completely filled with Portland cement, which binds the stone so firmly that there can be no ravelling or rutting. The cement on the surface wears just a trifle faster than the stone, thus always insuring enough roughness to give a good footing for horses or traction for automobiles. The color of the pavement is dependent upon the color of the stone, varying from the steel blue of the trap rock to the light gray of granite.

When it becomes necessary to make street openings, the same are easily repaired by the city authorities, it not being necessary to send for any apparatus or plant for mixing or preparing the material to repair the openings. After these openings have been repaired, and travel has been resumed over them, it is only a matter of a few weeks when the joints disappear and the places where the openings were repaired assume the same appearance as the remaining street.

By the use of the Hassam process the cost of concrete foundations for other paving materials can be reduced about 33 per cent. over the cost of ordinary mixed concrete, and in addition a much firmer, denser foundation is obtained; in fact, the Hassam pavement combines the advantages of any known pavement with the possible exception of noiselessness, in regard to which we would say that it is much more noiseless than granite block or brick, and the difference in noise cannot be detected from the asphalt or bitulithic paving, but it is not as noiseless as the creosoted wood block. In addition, the matter of cost is a strong argument for the use of the Hassam pavement, as it can be laid at much less expense than any other known pavement. The only equipment that is needed for laying this pavement is a steam roller, a mixer and a pump, and for a small area the mixing machine and pump can be dispensed with, the work being done by hand. Detailed information and estimates will be gladly furnished by application to the office of the Hassam Paving Company, 311 Main street, Worcester, Mass.

Judging from the remarkable success met with in the past six months, it appears evident that within the next few years it will become the most widely used pavement that there is on the market to-day.

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## A GROUND CONNECTION CLAMP.

The Chase-Shawmut Company have just put out to the trade a very neat flyer, describing the Shawmut All Copper Ground Connection Clamp which they manufacture.

This clamp, in view of the tendency of central stations to ground their secondary distributing systems, is a device which will prove of great service; it is made in two parts, and when installed, is locked in such a manner as to give the maximum contact upon the device upon which it is installed. The clamp is simple in construction and requires only a pair of plyers to install it quickly and properly.

It is also used to a large extent for grounding the metal sheaths on cable, and for grounding conduit installations. For this latter purpose it is recommended as the simplest and cheapest device on the market.

It is made in sizes from one-half to three inches, and is designed to take a number four wire.

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## PUMPING ENGINE AT HENDERSON, KY., OPERATES SEVEN YEARS WITHOUT A CENT SPENT FOR REPAIRS.

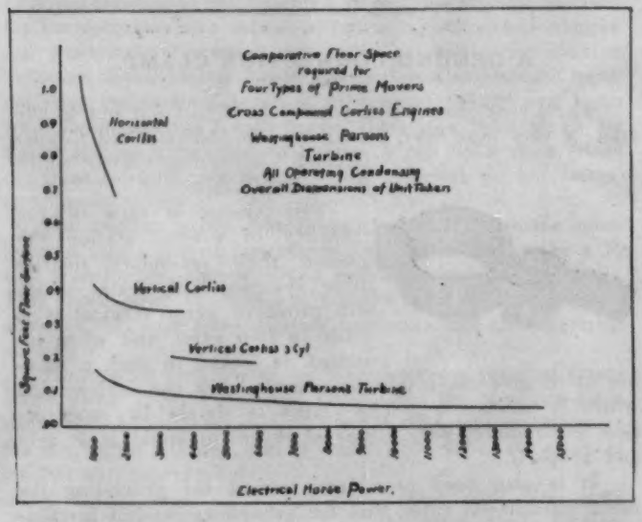
The Henderson Water Works Company, of Henderson, Ky., recently placed a contract with the Allis-Chalmers Company of Milwaukee for a new vertical cross compound pumping engine, having a capacity of six million gallons daily, against a domestic pressure of 172 feet, and a fire service pressure of 260 feet.

This pumping engine is similar in type to one also built by the Allis-Chalmers Company and installed at Henderson in 1899, with a capacity of three million gallons daily. The contract for the new unit was awarded largely on the merit of the older engine, which has made the following record: This engine has been in operation for a period of seven years without costing one cent for repairs, or having been shut down for any but natural causes during that period, in which time it made 64,000,000 revolutions.

## 10,000 KILOWATT WESTINGHOUSE TURBO UNITS FOR RAPID TRANSIT WORK IN BROOKLYN.

Electric generating units of 10,000 kilowatts capacity, complete in a single machine, have at last become a reality. The introduction of generating machinery of this size has been brought about by the contract recently executed between the Transit Development Co., of Brooklyn, and the Westinghouse Machine Co., of Pittsburg. This transaction is distinctive in carrying not only the largest single order ever placed for power generating machinery, but also units of the largest size contemplated at the present time. The new equipment will consist of five 10,000 kilowatt turbo generator units and a large amount of converting, transforming and controlling apparatus, all manufactured by the Westinghouse interests.

In compactness, the new unit establishes a new standard. Over all, the turbine measures 24½ feet in length, 15 feet in width and 12½ feet in height, above the floor level. This is equivalent to 3.8 b. horsepower (rated) per square foot occupied, or 5 2-3 b. horsepower maximum; conversely the turbine requires .026 square feet per rated b. horsepower, or .018 square feet per maximum b. horsepower. The combined unit measures approximately 48½ feet in length, equivalent to .075 square feet per kilowatt rated or .049 square feet per kilowatt maximum. That a striking advance has been




made within recent years toward securing greater compactness in prime movers is shown by the accompanying curve, and the end is not yet.

The turbine equipment is designed for a steam pressure of 175 pounds at the throttle, 100 degeees superheat and 28 seconds vacuum. Under these operating conditions assumed, the units are capable of sustaining their full rated load continuously with a temperature rise of 35 degrees C., with power factor ranging from 90 to 100 per cent. In the event of loss of vacuum, accidental or otherwise, the turbines will automatically "go to high pressure" carrying their full rated load without the assistance of a condenser. This feature will be obtained through the use of a secondary admission valve of construction similar to the primary valve and operated by the governor in such a manner as to automatically come into operation when the overload upon the machine reaches a certain point. The action of this valve is to raise the pressures in the various stages and thus increase the capacity of the machine.

Speed variation may be adjusted to a nicety by a distant control mechanism attached to the governor and operated from the switchboard. Close regulation may be obtained if desired when running alone, and when running in parallel with other machines the regulation may be changed to 3 per cent. or 4 per cent. if found desirable.

In the construction of the generator the standard rotating field design will be employed with frame entirely enclosed, so as to facilitate forced ventilation and incidentially obviate the noise emanating from high speed turbines. Current may be delivered at 6,600 or 11,000 volts, according to the method of connecting the windings.

A good feature of the horizontal type turbine is the excellent disposition which may be made of the condensing apparatus. In spite of the compactness of these large units, the surface condenser will be located, as usual, directly beneath in the power house basement, together with all of the condensing auxiliaries, thus giving a clear engine room floor that is not cluttered up by unsightly auxiliaries. This arrangement likewise permits of the most effective means of carrying out the "unit system" in power plant design, which is so important in securing the best arrangement of boiler plant.

It is significant that this new power equipment will be eventually installed in the new Kent avenue station, Brooklyn, where two large turbine units, by the same builders, and a third of another make, but similar design, have been in operation for some time. This station will, then, be distinctively devoted to turbine machinery, the first trying out of which in so important a service furnishes evidence of commercial superiority that may be regarded as conclusive.

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## WIRING IN CAR SHOPS.

The wiring problem in the car shop involves much the same restrictions in regard to fire risks that are encountered in any modern industrial structure, but after the insurance rules have been complied with there remain several other considerations which must be settled before a satisfactory installation can be made, says the "Street Railway Journal." Where the 600-volt trolley wire is carried into the shop over tracks extending from the car-house proper, special care is needed to prevent the falling of the exposed conductor upon the machinery beneath, because the most disastrous short-circuits may easily occur in case the overhead construction fails. The use of pipe conduit in pit wiring is quite as desirable to prevent mechanical abrasion of circuits as to forestall fires. Convenience of wiring also is worth taking many pains to secure, with respect to the regular and special work of the shop.

Shop-wiring must be inconspicuous and yet quickly accessible, if it is to be of the greatest service. Assuming that the proper sizes of wire have been figured for the different circuits, the problem is to so dispose of the wires that they will not in any way obstruct the movement of machines, materials and employees. Properly installed circuits need very little attention, but when taps are taken off the old lines for new machines it is exceedingly inconvenient and troublesome if the wires are more or less covered by bar iron, brake-shoes, spare coils of motors, shovels, and other articles whose storage rights have not been determined. It ought to be easy to follow the course of every shop power, lighting or heating circuit all through each department where it is carried without climbing up on barrels, tool racks and other impedimenta. Sometimes the concealment of circuits arises from the over-crowding of the shops, but if the wires are run in straight lines, with 90-deg. bends as high up on the walls away from the floor as is feasible in each shop, the chance of interference can be vastly reduced. As far as possible it is better to wire direct-connected motors on individually driven machines by iron conduit rising from the floor than by dropping connections from overhead. The value of the air space above machine tools for crane and hoist work in facilitating the movement of the work is still far from realized in many shops.

# NEWS NOTES

## ELECTRIC RAILWAYS.

San Francisco—Following the announcement that the United Railroads board of arbitration had agreed upon a 20 per cent. advance in wages for the company's men came news that the Oakland Traction Co. had advanced the pay of its men from 27½ cents an hour to 30 cents an hour for the first year, and an increase of 1 cent an hour each year of continuous employment up to ten years. This, it is claimed, makes the wages of the Oakland carmen higher than in any other city in the world. The effect of this advance has been to make the United Railroads employes dissatisfied with the findings of the arbitration board. While their pay under the new schedule will be practically the same as that of the Oakland men, the union leaders were most anxious to get an eight-hour day, as well as the advanced wage scale. The idea was to get $3 a day for the carmen and then to get an eight-hour day put through the legislature without reference to the wages. There is still a chance that they will succeed, as the board has not made a formal announcement of its decision, and in fact a change may be made, owing to the premature publication of its findings. The present schedule is: Twenty-five cents an hour for the first year, 26½ cents for the second year, and 27½ cents for the third year and thereafter, and a proportionate increase for all other platform men. Under this scale it makes little difference in respect to the number of hours fixed by legislation, or otherwise, as constituting a full day's work, for the men will be paid by the hour whether the day is long or short.

Redlands—Announcement has been made by Redlands capitalists, who are associated with W. F. Whittier of San Francisco, that Whittier has decided to build the road connecting Redlands with Hemet, which was surveyed several months ago.

Ely, Nev.—A company to be known as the Ely Electric Railroad Co. has petitioned the County Commissioners of White Pine County to grant a franchise for an electric railroad from the new town of Kimberly to the smelter site of the Nevada Consolidated Copper Co. The commissioners will consider the petition at the next meeting. The electric line will be used to haul both ore and passengers. If built, it will be the first electric railway in this portion of the State.

Long Beach—A telegram has been received from United States Senator Flint by Geo. H. Peck, the San Pedro banker, stating that the former had mailed a permit from the War Department giving Peck permission to cross the government reserve with an electric railroad to Point Firmin.

Prosser, Wash.—Council granted a franchise to the Prosser Traction Co. to build an electric line to connect with North Coast railroad on the north and the Columbia river on the south.

Portland—Council amended the ordinance granting a franchise to the Portland and Mount Hood Ry. Co. so as to require the company to build 10 miles of track outside the city within two years.

Portland—The Coos Bay Gas & Electric Co., recently organized by Henry Hewit, of Tacoma, Seymour H. Bell, of Sumpter, and Louis Simpson, of North Bend, will build an electric railroad to connect North Bend, Marshfield and Empire City.

Spokane, Wash.—Council decided to grant a franchise to the Inland Empire Ry. for a subway beneath Front avenue to be completed within two years, to cost $1,000,000.

Outlook, Wash.—The Columbia River, Outlook and Northwestern Railway Co., capital $3,000,000, has been incorporated by W. McF. Stewart and M. C. Stewart, to build a line of railway from Vancouver, Clarke county, to a point at or near the city of Spokane; principal place of business, Outlook, Yakima county.

Seattle, Wash.—The Seattle-Chelan-Spokane Railway Co., with branches at Spokane, Snohomish, and New York City, capital $17,000,000, has been incorporated by Charles M. Meeker and G. L. Stevens, 50 Broadway, N. Y.; Mark F. Mendenhall and John W. Fry, Spokane; P. P. Carroll, Francis M. Carroll, of Seattle; Charles A. Barron, O. M. Cochran, Elliott Colburn, E. Wright, Snohomish; E. E. Congdon, Butte.

## ENGINEERING.

Boise, Ida.—Alex. McPherson of Twin Falls states that the Twin Falls Land & Water Co. has decided to commence work at once on the north side canal. It will open to settlers 180,000 acres more land. The company will also build an electric line from the Milner dam to Gooding.

Blackfoot, Ida.—The Lost River Construction Co. has been awarded the contract by the Big Lost River Land & Irrigation Co. for the construction of the necessary irrigation works to reclaim the 80,000 acres of the Carey land in the Lost River Valley.

La Grande, Ore.—The Imbler Ditch Co., capital $5,000, has been incorporated by L. Oldenberg, R. Logan and E. L. Parr.

Medical Lake, Wash.—Eslick Bros. have been awarded the contract for the ditch work on the east shore of Silver Lake which is to carry the water to be used by the Hazelwood Co. in irrigating a large tract of land north of the town. E. A. Oliver has the contract for building a bridge across the north of the lake, a distance of 1000 feet.

Olympia, Wash.—A bill will be introduced into the State Legislature calling for an appropriation of $40,000 to provide for the survey of the unsurveyed lands of the State in connection with the work of the U. S. Geological Survey, and also making provision for the preparation of maps showing the general topography of the country as to the mineral deposits, timber resources, and available water supply.

Salem, Ore.—The State will be asked to appropriate $300,000 contingent on the government supplementing that sum with enough either to buy the existing locks or to build new ones.

Tacoma, Wash.—Mark Maynard has made application to the county commissioners for the right to construct and operate a water works system along certain county roads.

Seattle, Wash.—The Lake Creek Water Co. has incorporated with $500,000 capital by Henry Anderson, R. F. Parkhurst and J. L. Finch.

Walla Walla, Wash.—Senator Ankeny has taken up, with the director of the geological survey, the feasibility of irrigating a 40,000 acre tract of land lying along the Tucanon River in Garfield and Columbia counties.

Washington, D. C.—The government has authorized the following surveys: Chehalis River to Montesano, with a view to the removal of the bar; Cowlitz River up to Castle Rock; Puyallup River, to straighten channel; Skagit River to Sedro-Woolley, Blaine harbor and Bellingham harbor.

## TELEPHONES AND TELEGRAPHS.

San Francisco—The Pacific Telephone and Telegraph Co. is about to take control of the Southern Nevada Telephone and Telegraph Co., which circles the mining camps of Southern Nevada. When the Pacific States Tel. & Tel. Co. combined with the Sunset Tel. & Tel. Co. there was a bond issue for the improvement of the company's holdings and for the purchase of new plants. The purchase of the Nevada company is the first of these proposed extensions. At present the Pacific Tel. & Tel. Co. has no communication with the mining districts, but a direct wire will be immediately installed to Goldfield. The Southern Nevada Tel. & Tel. Co. stock is held principally by Malcolm MacDonald, president of the company; Key Pittman, vice-president; W. Y. Williams and D. G. Doubleday, the last named a local mining broker.

Washington, D. C.—Senator Ankeny has been assured that the Senate Committee on Military Affairs will put an item of $190,000 in the military appropriation bill for the extension and improvement of the Alaska telegraph system. It is proposed to put in a second line between Valdez and Fairbanks and to extend the system from Fairbanks to Circle.

Lodi—C. E. Young, with the Sunset Telephone Co., is in Lodi, making arrangements with the local farmers to install a new telephone system. The farmers heretofore have used the barb wire along their fences for their phones, and it will not be long before a new system devised by the Sunset company will be installed in Central California.

Calgary, Alba—Council is planning to install an independent telephone system.

Portland, Ore.—The Home Telephone Co. is laying pipes for underground lines on Grand avenue. The system will be in operation in about thirty days.

Portland, Ore.—The damage to the Pacific States Tel. & Tel. Co. the past week is estimated at $200,000.

Snohomish, Wash.—The Farmers' Independent Tel. Co. have a crew of men at work stringing extra wires.

Skagway, Alaska.—This city and Whitehorse are now connected by telephone.

Leland, Wash.—The Inter Farmers' Tel. Co., capital $10,000, has been incorporated by J. H. Munn and William Bishop.

Pullman, Wash.—The rural telephone line from Pullman to Chambers, Wash., known as the Barbee-Fletcher line, has been sold to a company of farmers, headed by S. H. Breeze, of Pullman. The line will be extended to Johnson, Colton and other towns further south and through the surrounding country.

Moscow, Idaho—Thomas Elson, superintendent of construction of the Pacific States Tel. Co., is here to investigate the local system and make arrangements to install a new and up-to-date exchange.

Roseburg, Ore.—G. P. Mock, of the Pacific States Tel. Co., is here preparatory to installing a new central energy system. A complete cable system is also contemplated.

Victoria, B. C.—The C. P. R. Steamship Co. has decided to equip all its steamers with wireless telegraphic apparatus.

Walla Walla—George Coombs of San Francisco has taken charge of the local office of the Pacific Tel. & Tel. Co., succeeding J. E. McGillivray.

## WATERWORKS.

Sacramento—Sealed bids are being received by the city clerk for cast-iron pipe for the extension of the water distributing system in this city. Sixty pieces of 10-inch pipe, each 12 feet long, exclusive of hub; 235 pieces of 12-inch pipe, each 12 feet long. Specifications on file with M. J. Desmond, city clerk.

Berkeley—Work is progressing rapidly on the pumping plant being installed by the People's Water Co. at the wells at San Pablo Creek Basin beyond Stege. Contracts for the machinery have already been let and, according to General Manager Louis Titus, the material will be rushed to the place of operation immediately. Four well-boring gangs have during the past week sunk numerous wells on the premises, and two more will be in operation before the end of the week. "Our plan is to construct the pumping plant as soon as possible," said Mr. Titus. "We also intend to commence the laying of the main pipe into West Berkeley in a few weeks. Machinery is now on its way from the East, to be installed at the pumping station. Millions of gallons of water will be forced through the huge main, four feet in diameter. It is estimated by our engineers that at least $5,000,000 will be expended in this one particular venture, possibly including the pipe line to be run from the San Pablo reservoirs, in the Contra Costa hills, through upper portion of Berkeley."

Modesto—Sealed bids are being received by W. O. Thompson, clerk, for cast pipe and fittings, 3,000 feet of 8-inch pipe, 1,600 feet of 6-inch pipe, 430 feet of 12-inch pipe, two crosses 4x4x6x6, two crosses 8x8x6x6, one cross 8x8x6x12, one cross 12x12x12x6, one tee 12x12x6, one 90-deg. elbow 12x12, one plug 12-inch, three plugs 8 inches, three gates 6-inch, one gate 8-inch.

Susanville—Judge Kelley, of the Superior Court of the County of Lassen, has handed down a decision involving title to the waters of Eagle Lake. For nearly two years the Lassen-Willow Creek Water Co., on the one side, and R. M. Rankin and A. F. Dixon on the other, have been contesting the right to tap Eagle Lake by means of a tunnel, the waters of the lake to be used for irrigating a large tract of arable land in Honey Lake Valley. The court, in its decision, gives judgment in favor of the Lassen-Willow Creek Water Co., a corporation, and enjoins the defendants, or their agents, from interfering with the works of the plaintiff. Now that the rights of the latter company have been adjudicated, the work of tapping Eagle Lake will be resumed with vigor and prosecuted to a finish. The completion of this work means much for Lassen County in particular and Northeastern California in general.

Greenwater—A water supply scheme is now being planned here to furnish not only this camp and its big copper smelter, but also Bullfrog, Johnnie, Rhyolite, Lee and the adjacent camps. The prime movers in the enterprise are Judge L. O. Ray and Governor L. A. Waters, of Scranton, Pa. Associated with them are capitalists who control Eastern investment money. The same men backed a $14,000,000 enterprise to furnish Scranton with water. According to their plans, ditches will convey the water to a big reservoir in the Funeral range, situated at sufficient elevation to give the water the proper fall to the towns to be reached. The company is incorporated for 5,000,000 shares, 2,000,000 in the treasury. Sufficient treasury stock is sold to provide ready capital to push the great work mapped out.

## OIL.

Coalinga—The Associated Oil Co. is about to commence drilling a number of wells on section 36, township 20, range 14, recently purchased from McKeveit, Hall and others. This section is considered as gilt edge oil land and looks like the only valuable piece of property thus far acquired by the Associated in the Coalinga field, excepting, of course, the Sauer Dough and "National 30" properties. Work will be resumed on the W. K. Oil Co. well on section 2, township 19, range 15, soon, as the roads are in condition to warrant hauling fuel. Soon as well No. 1 is completed work will be started on well No. 2. It is rumored that the Associated will put down a test well on its property on section 8, township 21, range 15, recently purchased from A. G. Myers.

## POWER AND LIGHT PLANTS.

Blaine, Wash.—The plant of the Blaine General Electric Co. shut down for a period of 60 days.

Tacoma, Wash.—Proposals will be received until February 16th for supplying electric current for five years from November 8, 1907.

Waitsburg, Wash.—It is reported that Roberts & Henderson are making arrangements to enlarge the capacity of their light plant.

Los Angeles—Plans for a rival gas company, financed by leading capitalists and bankers of this city, were made public February 5th, by the filing of articles of incorporation of the City Gas Co. of Los Angeles, with a capital stock of $1,000,000, nearly all of which has been subscribed. The directors include J. F. Sartori, J. E. Fishburn, W. E. McVey, R. H. Miner, W. M. Garland, H. W. Frank, and M. J. Connell. The City Gas Co. is intended as a holding of construction company for the Domestic Gas Co., for which articles of incorporation will be filed today. It will have a capital stock of $10,000,000 and will become owner of all the improvements and property acquired by the City Gas Co. The directors of the Domestic company are: O. T. Johnson, W. S. Bartlett, M. S. Hellman, E. T. Stimson, H. Jevne, W. F. Botsford and W. D. Woolwine.

Los Angeles—The Richardo Land and Water Co. has been incorporated with a capital stock of $1,500,000, by Rudolph Hagen, A. Ryon, J. S. Guen and J. V. Ham.

Los Angeles—The Domestic Gas Co. has been incorporated with a capital stock of $10,000,000 by O. T. Johnson, W. S. Bartlett, M. S. Hellman, E. T. Stimson, H. Jevne, W. F. Botsford and W. D. Woolwine.

Los Angeles—The Taylor & Walker Electric Co. has been incorporated with a capital stock of $5,000, by W. F., C. E., Josephine L. and Jessie M. Taylor.

Los Angeles—About 2½ miles from Huntington Beach a small gas plant has been erected at a cost of $65,000 by Los Angeles and Redlands capitalists, where soon will be demonstrated the feasibility of manufacturing fuel gas from peat, from which, when properly treated by a cheap chemical process, a gas for domestic as well as industrial purposes can be had. The company has a large acreage.

Los Angeles—There is possibility of a merger between the new Domestic Gas Co. and the People's Gas and Coke Co. Details of the organization of the Domestic Gas Co. are being worked out by the association of local capitalists, headed by J. F. Sartori and Dr. John R. Haynes. President Sartori of the Domestic company states they are making good progress with their plans for installing a gas plant.

San Francisco—Chas. Dickman is in Nevada at present trying to establish a line of gas plants from Goldfield to Bullfrog. It is reported that the project is well backed by local capital.

## INCORPORATIONS.

San Francisco—The California-Nevada Electric Power Co. filed articles of incorporation last week with $10,000,000 capital stock. The company has plans to build and operate plants for manufacturing, transmitting and supplying electric light in California and Nevada. A large number of the power houses will be operated by water power, but where that can not be used provision has been made for the use of other power. The directors are: R. E. Maynard of Los Angeles, F. G. Baum of Berkeley, F. V. Keesling of San Francisco, C. R. Leevers of Reno, and O. K. Grau of this city. The directors have $5,000 of the capital stock.

San Bernardino—The Redlands and Yucaipe Electric Railroad has been incorporated with a capital stock of $1,000,000, by C. S. Chestnut and G. H. Dunn, $800 each; O. D. Collins $200; O. M. Miller and A. A. Moore, $100 each.

## FINANCIAL.

Los Angeles—This year only the Los Angeles Gas and Electric Co., the Pacific Light and Power Co., and the Edison Company have made their reports. The People's Gas (Lowe) and the telephone companies have ignored the law altogether. One of the requirements is that the companies shall state the valuation of their holdings. This has been complied with by the companies reporting. The Los Angeles Gas and Electric Co. makes the following report of holdings:

| In Los Angeles— | Actual cost. | Present value. |
|---|---|---|
| Gas meters | $ 373,352 | $ 333,336 |
| Gas services | 624,331 | 567,942 |
| Gas works | 1,641,526 | 1,473,095 |
| Minor imp. (70 per cent.) | 21,956 | 16,864 |
| Office bldg. (70 per cent.) | 52,689 | 50,068 |
| Real estate | 270,848 | 504,360 |
| Regulators | 16,983 | 15,327 |
| Stable (70 per cent.) | 4,901 | 4,302 |
| Street mains | 2,334,139 | 2,172,518 |
| Totals | $5,340,729 | $5,137,844 |
| In county of Los Angeles— | | |
| Gas meters | $ 12,736 | $ 11,371 |
| Gas services | 28,194 | 25,648 |
| Regulators | 121,872 | 113,427 |
| Totals | $ 169,457 | $ 156,452 |
| Grand totals | 5,510,137 | 5,294,297 |

The Pacific Light and Power Co. and its subsidiary companies reports: Land, $456,306; steam and hydraulic power plants complete, $2,950,786; transmission and distribution systems, $1,874,474; horses, wagons and harness, $10,197; total $5,291,764. Replacements $455,476. Actual cost of properties, $5,747,240.

The Edison Electric Co. furnishes these figures; Real estate and buildings, $386,940; steam plants, $244,260; electric plants, $396,783; shops, $6,298; stables, $8,162; testing appliances, $548,799; water wheel plants, $33,918; hydraulic plants, $548,799; hydro-electric plants, $95,150; transmission and distribution systems and material, $1,561,287; cash value, $3,289,493. Actual cost of above, $3,618,199.

San Francisco—The Potomac Oil Co., under date of January 25th, has declared a dividend of a quarter of a cent a share and makes the announcement that "The management hopes to pay another dividend in May or June of this year, upon the payment of the last installment of the storage oil." Thomas Scott is president of the company.

San Francisco—The financial statement of the Truckee River General Electric Co., for the year 1906, is as follows: Cash on hand Jan. 1, 1906, $6,567.32; gross receipts for year, including California and Nevada, $165,858.10; total, $172,425.42. Total disbursements for the year, $168,527.26; cash balance December 31, 1906, $3,898.16; total, $172,425.42.

San Francisco—Assessor Dodge reports that the total assessment of the Spring Valley Water Co. for 1906 is $6,898,592, of which $1,073,170 is real estate, $611,300 improvements, $3,214,122 personal property, and $2,000,000 franchises.

Los Angeles—The annual report of the Amalgamated Oil Co., submitted February 1st, shows the net earnings to be $442,814.93. The gross gain, including the earnings of the Utah, California Consolidated, the Salt Lake and the Areturus companies, is $1,786,479.29. Burton E. Green, president, and the old officers and directors were re-elected.

Bakersfield—The Sea Breeze Oil Co. has levied assessment of ½ of 1c per share, delinquent March 4th, sale day March 21st. L. Hirshfeld, secretary, room 5, Conklin building, 1926 Chester avenue, Bakersfield, Cal.

## FINANCIAL.

San Francisco, Cal—The Spring Valley Water Company has filed with the supervisors a statement showing that the cost of its permanent improvements for 1906 were as follows: Real estate and lands in San Francisco, San Mateo, Alameda and Santa Clara counties, $167,290.07; new construction, consisting principally of the labor of laying cast-iron pipe and cost of materials for such work, $501,095.79. The sundry sales of real estate and material amounted to $238,450.03. The operating expenses during year 1906 amounted to $486,775.60, and for the six months ending December 31, 1906, they were $261,917.65. The receipts for the same six months were $786,886.76, and the expenditures $1,431,743.80. The company claims that its records previous to April 18, 1906, were destroyed, and it is unable to give additional data required by the supervisors. The municipal reports for 1902 and 1903 show the following financial operations of the company: Receipts, half-year ending December 31, 1902, $1,010,317; half-year ending June 30, 1903, $1,013,416.67, and December 31, 1903, $1,062,566.42. The expenditures for the same periods, respectively, were $1,088,-994, $923,015.46 and $1,166,591.70, of which $374,221.55, $334,-839.67 and $373,140.37, respectively, were for permanent improvements. The records of the supervisors for other years were destroyed last April.

Oakland, Cal.—The People's Water Company of Oakland has given a deed of trust to the Mercantile Trust Company covering its entire properties in Alameda and Contra Costa counties, and serving as a mortgage to secure the payment of a $20,000,000 bond issue which the new company's directorate has authorized.

Sacramento, Cal.—Relative to the reported sale of all the property of the Sacramento Gas and Electric Railway Company, a thorough investigation of the system has been made by a corps of expert engineers and explanation offered that this procedure was caused by bondholders who desired to know exact conditions on the system. Since that time careful investigation of all papers, abstracts, titles and claims of and against the company have been closely scrutinized by expert searchers, and a complete abstract of all property of the street-car company is being prepared. This, in connection with the fact that a flattering offer has been made for the property of the Central California Traction Company, gives color to the story that the local street railway is soon to pass into other hands and that an effort to acquire all electric railway properties in this section is being made. It is generally understood that H. E. Huntington is in the field for all electric railway properties that are prosperous in Northern California, and that he will soon be the proprietor of the Sacramento Gas and Electric Railway system. It is rumored that John Martin, the largest holder of stock in the Bay Counties Power Company, is anxious to dispose of his holdings and that the sale of the local street-car system is prompted by his desire to quit the street-car business.

Sacramento, Cal.—It has been unofficially announced that Manager F. E. Fitzpatrick, of the Sacramento Gas, Electric and Railway Company, is soon to become the general manager of all the properties of the Bay Counties Power Co., and that Charles K. McKellip will succeed to his position as superintendent of the Gas, Electric and Railway Company.

Oakland, Cal.—The owners of the Claremont Hotel have contracted for all work on installation of a power plant, boilers, engines, dynamos, etc.

FOR GAS COMPRESSORS see RIX C. A. & D. Co., S.F.

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**Engineers and Contractors**
Brooks-Follis Elec. Corporat'n
Bay Shore Elec. Const. Co.
Byllesby & Co., H. M.
California Electrical Works
Cannon, Edward F.
Century-Klein Co.
Cole Co., John R.
Copeland, Clem A.
Doble Co., Abner
Cory, C. L.
General Electric Co.
Hunt, Dillman, Meredith & Allen
Hall, Leon M.
Hunt, Mirk & Co.
Jackson, D. C. & W. B
Kilbourne & Clark Co.
Smith, Emery & Co.